

# 2009 Calendar

IMPROVE



Interagency Monitoring of Protected Visual Environments

Colorado  
State  
University



# IMPROVE Monitoring Update

The IMPROVE (Interagency Monitoring of Protected Visual Environments) program consists of 110 aerosol visibility monitoring sites selected to provide regionally representative coverage and data for 155 Class I federally protected areas. Additional instrumentation that operates according to IMPROVE protocols in support of the program includes

- ◆ 59 aerosol samplers,
- ◆ 34 nephelometers,
- ◆ 4 transmissometers,
- ◆ 4 digital camera systems,
- ◆ 58 webcam systems,
- ◆ 5 interpretive displays.

Data and visualization tools can be found on the IMPROVE web-site at <http://vista.cira.colostate.edu/improve/Data/data.htm> and on the VIEWS site at <http://vista.cira.colostate.edu/views>.

Photographic slide spectrums are available on the VIEWS Web site under Imagery. Real-time Webcamera displays are available on the following agency-supported websites ...

Visibility Information Exchange Web System: <http://vista.cira.colostate.edu/views/Web/WebcamsClass1/webcam.htm>  
National Park Service: <http://www.nature.nps.gov/air/WebCams/index.cfm>  
USDA-Forest Service: <http://www.fsvisimages.com>  
CAMNET (Northeast Camera Network): <http://www.hazecam.net>  
Midwest Haze Camera Network: <http://www.mwhazecam.net>  
Wyoming Visibility Network: <http://www.wyvisnet.com>  
Phoenix, Arizona Visibility Network: <http://www.phoenixvis.net>

## Network Notes

The Breton Island, Louisiana aerosol site resumed operations in late January 2008. The U.S. Fish and Wildlife Service site is now active following a lengthy suspension due to Hurricane Katrina, its new site designation is BRIS1.

Two NGN-2a nephelometers were installed in the IMPROVE optical network in January 2008. Great Basin National Park, NV and Rocky Mountain National Park, Colorado both received nephelometer systems.

The CAMNET-sponsored Brigantine Wilderness Area, NJ dual digital camera system became operational in March 2008.

The CAMNET Web site now has a link, "More Hazecams", that enables access to other, non-sponsored air quality Web sites with digital cameras.

The Cucamonga Wilderness camera site, sponsored by the USDA Forest Service, was upgraded in March/April 2008. The remote digital camera system, which collects and stores images on a thumb drive, was replaced by a webcam system.

The IMPROVE sampler controller received an enhanced programming update. Air Resource Specialists, Inc., continues to work with UC Davis staff to improve and enhance the IMPROVE aerosol sampler firmware. Initial

improvements addressed reliability and memory card issues, and current enhancements add additional functionality including custom schedules for special studies, controller configuration via the memory card, detailed memory card data and log files, and a cleaner user interface.

## Data Advisories Released

Note: Complete discussions on all data advisories can be found on the IMPROVE Web site at [http://vista.cira.colostate.edu/improve/Data/QA\\_QC/Advisory.htm](http://vista.cira.colostate.edu/improve/Data/QA_QC/Advisory.htm). Two of the latest are:

Re: Titanium

Positive interference in PIXE titanium determinations

**Affects:** Module A, Titanium. **Period:** Before December 1, 2001.

In samples collected before December 1, 2001, the elements Na to Mn were determined by proton-induced X-ray emission (PIXE) on the Crocker Nuclear Laboratory cyclotron. These elements have since been determined by conventional X-ray fluorescence (XRF), which has an order-of-magnitude lower detection limit for titanium. Most titanium in ambient particles is attributed to soil dust, but concentrations determined by PIXE were high and variable relative to other crustal elements. The PIXE readings appear to have included stray contributions from the Ti-containing slide frames in which filters are mounted. Scientists recommend data users estimate Ti from Fe and other crustal elements in pre-December 1, 2001, samples.

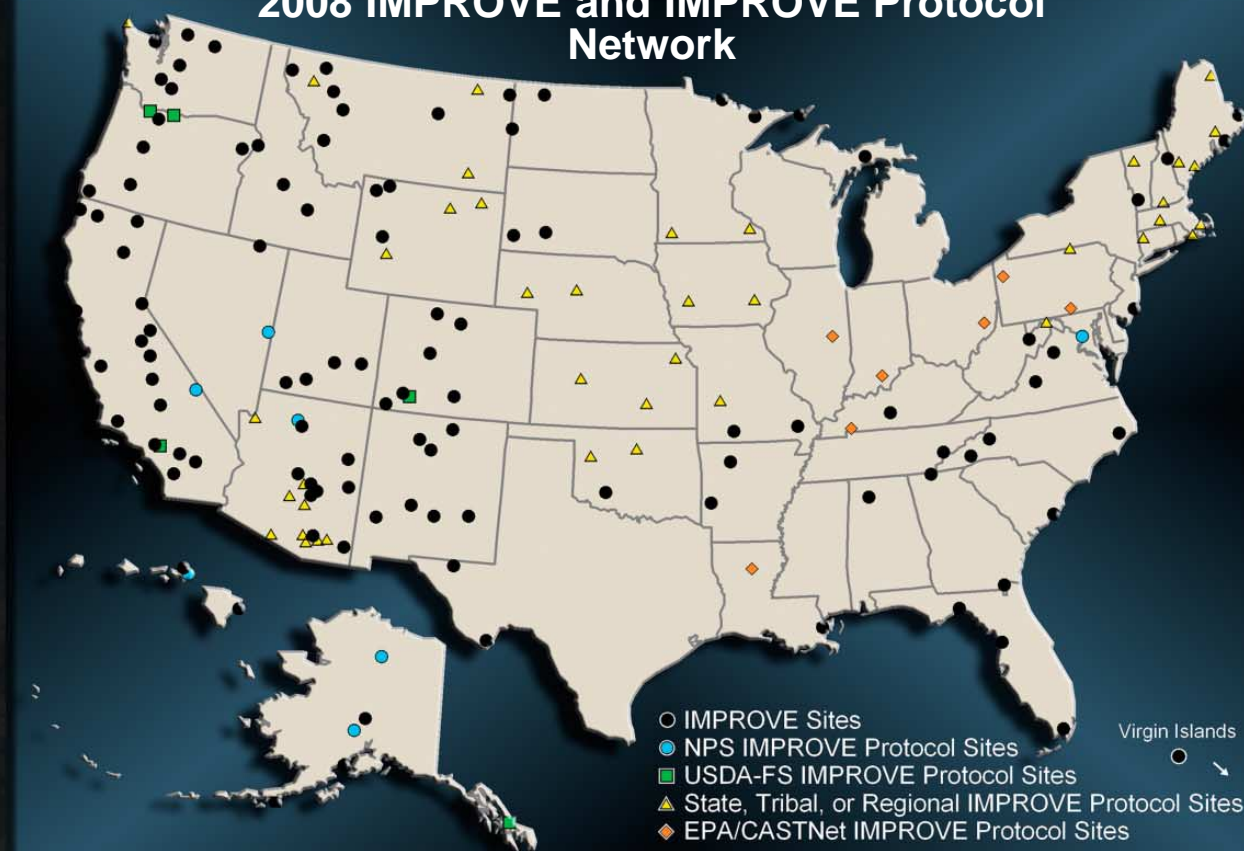
Re: Bias between masked and unmasked elemental measurements

**Affects:** Module A, Sulfur. **Period:** Evident since 2002.

Until recently, masks were used at many sites in the IMPROVE and IMPROVE Protocol networks to reduce the nominal collection area of A-module filters from 3.53 cm<sup>2</sup> to 2.20 cm<sup>2</sup>. Masking improved XRF sensitivities at low concentrations but caused occasional clogs at high concentrations. As of 2008, all filters have been unmasked.

A relative bias between masked and unmasked elemental measurements can be seen by comparing the sulfur/sulfate ratios measured under both conditions. Sulfate ion concentrations have generally reported about 5% more sulfur than masked sites at a given measured sulfate concentration, and the sulfur reported from masked sites has typically risen by about 5% when they have converted to unmasked operation. It is not known whether these differences reflect under-reporting from masked samples or over-reporting from unmasked samples, or contributions from both. This advisory includes all sites in the IMPROVE and IMPROVE protocol networks. It is recommended that data users should consider the masking status of the filters when evaluating small differences in time and space.

## 2008 IMPROVE and IMPROVE Protocol Network





# Bandelier National Monument, New Mexico

Mango Kucera (right) and Niki vonHedemann (below) are two Student Conservation Association (SCA) interns who currently manage the IMPROVE modular aerosol sampler at



Bandelier National Monument in northern New Mexico. The Ecology Group at Bandelier, a combination of NPS and USGS employees, always has two interns who aid the primary operator, Kay Beeley, in sampling and

maintaining the IMPROVE station. The interns also read dendrometer bands and service other weather stations.

The nearby cities of Los Alamos, Santa Fe, and Albuquerque, all of which can be seen from the mesa where the IMPROVE sampler is located, affect the air quality of the area, as do the many wildfires and prescribed burns. Despite this, air quality and visibility at Bandelier are usually quite good, benefiting the many visitors who take advantage of outdoor recreation in the area, such as visiting archaeological sites, hiking, rock climbing, skiing, and biking.

Niki and Mango also work on a variety of other projects conducted by Bandelier's Ecology Group. Last summer they collected fire scars in the Valles Caldera National Preserve, read a variety of vegetation transects for long-term ecological monitoring, measured sediment for a long-term erosion project, and collected data for many other projects focusing on climate change and forest dynamics.

Mango is an undergraduate at Evergreen State College, working at this internship to gain on-the-job experience in ecological and hydrological field methods and quantitative analysis. She enjoys scouting for rocks and minerals, and collecting edible mushrooms. Niki is a recent graduate of Rice University, hoping to use her internship as a stepping stone to get a job with the government's public land agencies. She has taken up rock climbing since moving to the area and loves to explore Bandelier's backcountry archaeological sites.



# January

"The packaging for a microwavable "microwave" dinner is programmed for a shelf life of maybe six months, a cook time of two minutes, and a landfill dead-time of centuries."

- David Wann, *Buzzworm*, November 1990

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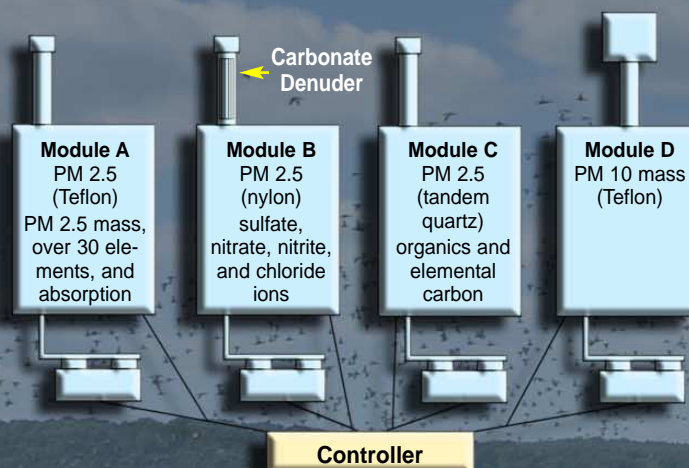
Operator Involvement -- The Key to Network Success



# The IMPROVE Aerosol Sampler



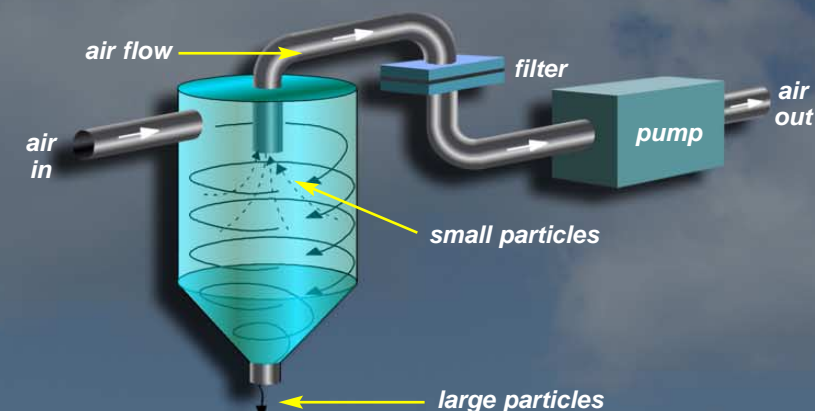
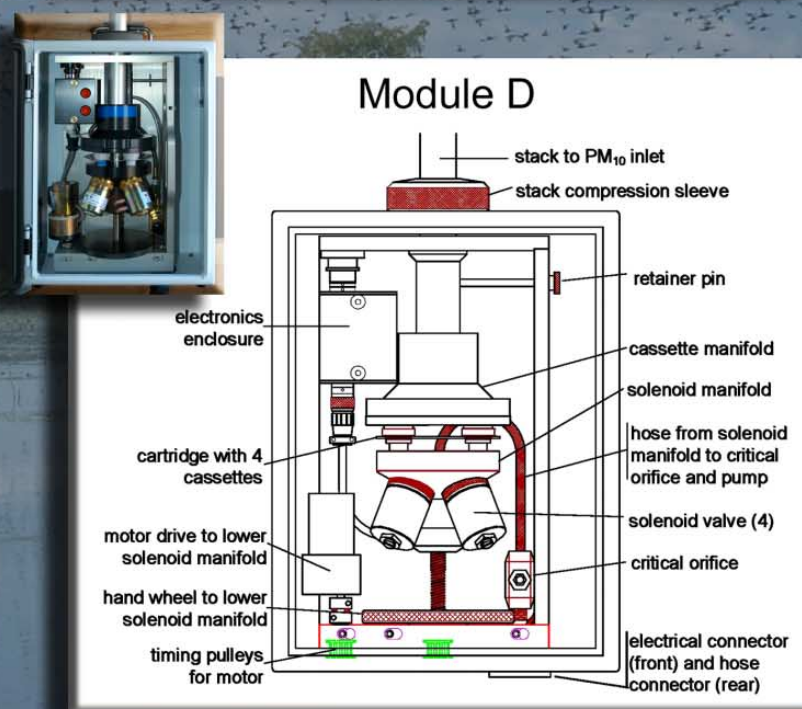
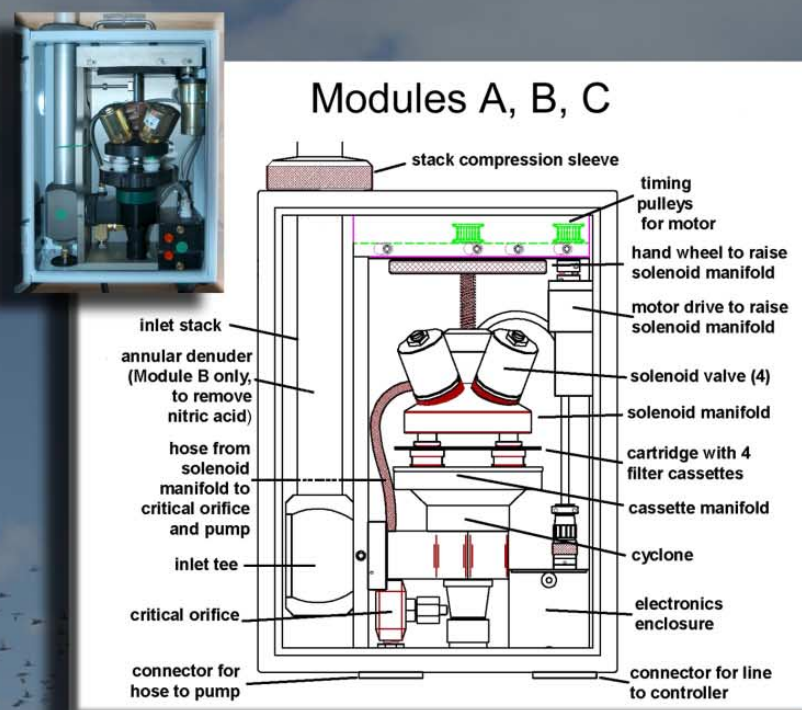
Monitoring of particulate concentrations began at some national park service sites in 1979. Today, all IMPROVE program sites conduct particle sampling to pinpoint the types of particles causing visibility degradation. Through sample analysis, the particle sizes, chemical compositions, and concentrations can be characterized. Particle measurements in conjunction with optical measurements allow estimation of the sources of visibility impairment.



The standard IMPROVE particulate sampler has four sampling modules. Modules A, B, and C collect fine particles (2.5 microns and smaller [ $PM_{2.5}$ ]), while module D collects larger particles (10 microns and smaller [ $PM_{10}$ ]). Fine particles have the greatest impact on visibility, can adversely affect human health, and are often the result of human activities. The coarse mass (particles larger than 2.5 microns) is primarily composed of soil and carbonaceous material and is often of natural origins. IMPROVE aerosol data are used for assessing the contribution of various sources to haze. In addition, these data are the basis for tracking progress related to the regional haze regulations.

Prior to 2000, two 24-hour samples were collected twice a week. After 2000, samples have been collected every three days.

## IMPROVE Samplers in Detail



The IMPROVE fine particle modules employ a cyclone at the air inlet that spins the air within a chamber. Fine particles are lifted into the air stream where they are siphoned off and collected on a filter substrate for later analysis. The large particles impact on the sides of the chamber and fall into a collection cup at the bottom.

Filter analysis provides concentrations and composition of atmospheric particles. Common fine particles include sulfates, nitrates, organic material, elemental carbon (soot), and soil. An indication of source contribution to visibility impairment can be obtained from the analysis of trace elements.

vanadium / nickel	↔ petroleum-based facilities, autos
arsenic	↔ copper smelters
selenium	↔ power plants
crustal elements	↔ soil dust (local, Saharan, Asian)
potassium (nonsoil)	↔ forest fires

## IMPORTANT! VALID MEASUREMENTS

A visibility impairment value is calculated for each sample day. To get a valid measurement, all four modules must collect valid samples. The regional haze regulations use the average visibility values for the clearest days and the worst days. The worst days are defined as those with the upper 20% of impairment values for the year, and the clearest days as the lowest 20%. The goal is to reduce the impairment of the worst days and to maintain or reduce it on the clear days. For a site's data to be considered under the regional haze regulations, criteria have been set to determine the minimum number of daily samples needed to have a valid year. There are both annual and seasonal criteria. The criteria are

- ◆ 75% of the possible samples for the year must be complete,
- ◆ 50% of possible samples for each quarter must be complete,
- ◆ no more than 10 consecutive sampling periods may be missing.



# Mingo National Wildlife Refuge, Missouri



Jason Lewis is a wildlife biologist for the U.S. Fish and Wildlife Service at Mingo National Wildlife Refuge. He received an M.S. in biology from Ball State University. His current research interests involve improving our scientific knowledge of forest, grassland bird, and invasive plant ecology and management. He is a passionate bird watcher and outdoor enthusiast who enjoys hiking, hunting, fishing, and camping. Jason lives in southeastern Missouri with his wife Gwen, newborn daughter Willow Ann, and two dogs. Jason's most memorable wildlife observation was the identification and documentation of an Audubon's Oriole in Indiana.

The IMPROVE site provides valuable data used to assess environmental impacts on the refuge's pristine wilderness area. Mingo NWR has nearly 8,000 acres of cypress swamps and bottom land hardwood forest designated as a wilderness area -- "...where the earth and its community of life are untrammelled by man, where man himself is a visitor who does not remain." Visitors are welcome to walk, canoe, photograph, fish, and study nature here.



# February

"Humankind has not woven the web of life. We are but one thread within it. Whatever we do to the web, we do to ourselves. All things are bound together. All things connect."  
- Chief Seattle, 1855

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
<b>1</b> 32 Julian day	<b>2</b> 33 Groundhog Day	<b>3</b> 34 IMPROVE particle sampling day  Special IMPROVE particle change. Move cassette 3 from old cartridge to new.	<b>4</b> 35	<b>5</b> 36	<b>6</b> 37 IMPROVE particle sampling day	<b>7</b> 38
<b>8</b> 39	<b>9</b> 40 IMPROVE particle sampling day	<b>10</b> 41 Change IMPROVE particle cartridges.	<b>11</b> 42	<b>12</b> 43 Lincoln's Birthday IMPROVE particle sampling day	<b>13</b> 44	<b>14</b> 45 Valentine's Day
<b>15</b> 46 IMPROVE particle sampling day	<b>16</b> 47 Presidents Day	<b>17</b> 48 Change IMPROVE particle cartridges.	<b>18</b> 49 IMPROVE particle sampling day	<b>19</b> 50	<b>20</b> 51	<b>21</b> 52 IMPROVE particle sampling day
<b>22</b> 53 Washington's Birthday	<b>23</b> 54	<b>24</b> 55 IMPROVE particle sampling day  Special IMPROVE particle change. Move cassette 3 from old cartridge to new.	<b>25</b> 56	<b>26</b> 57 Grand Canyon National Park established, 1919	<b>27</b> 58 IMPROVE particle sampling day	<b>28</b> 59

- ◆ Electrical connections (e.g., extension cords) exposed to wet conditions should be GFCI protected.

- ◆ Watch for frost on the inlets.

UC Davis: Sampler:  
General Lab  
(530) 752-1123

ARS: Optical:  
Carter Blandford or  
Karen Rosener  
Photography:  
Karen Fischer  
(970) 484-7941

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Operator Involvement -- The Key to Network Success



# IMPROVE Aerosol Sampling Protocols

# Sampler Filters



The "blue box" has three dates listed on it. These are the dates (all **Tuesdays**) on which the filters must be installed. Each blue box contains

- 1 flash memory card,
- 3 labeled Ziploc® bags,
- 1 bag/week labeled with install date and
- 4 color-coded cartridges, one for each module.



Stack of filter cartridges with log sheet.



Four filter cartridges:  
**Red** for Module A  
**Yellow** for Module B  
**Green** for Module C  
**Blue** for Module D

The "blue box" has three dates listed on the box. These are the dates on which the filters must be installed (all **Tuesday** dates).

If for any reason you or your backup cannot make a change on a particular Tuesday or the "blue box" is late, or for any problem or question, immediately call UCD's General Lab at (530) 752-1123. Discussing a problem first will avoid confusion, and a proper diagnosis is more likely to be made. **NO** problem is too small; it could be a sign of bigger problems, such as unusual readings. E-mail to UCD field operations should only be used if phone contact cannot be made. E-mail addresses are in the format of **Lastname@Crocker.UCDavis.Edu**.

The IMPROVE network operates on the one-day-in-three protocol. Sample change is always on **Tuesday**. (Arrangement of ambient filters varies each week; pattern repeats every third week.)

**For two of the three weeks**, the sampler will not be operating on the sample-changing day the operator records final readings, replaces old cartridges, and records the initial readings. There will be initial or final readings for the filter in position 3 on two of the three weeks. The log sheet and display indicate when values for position 3 are recorded.

**Every 3rd week**, the sampler will be operating when the operator arrives. When sample change is initiated the controller will

- ◆ suspend sampling.
- ◆ read flow rates on all filters and display and record information.
- ◆ transfer the cassette in position 3 from the old cartridge to the new one. (New cartridges have no cassette in position 3. The cassette in position 3 has a black O-ring attaching it -- the only one that can be removed without a special tool.)
- ◆ transfer the cassette and install a new cartridge. After the initial readings are taken, the sampler will resume collection on the filters in position 3.

The field blanks in position 4 are transparent to the operator and to the sampler controller. Flow rate measurements are not taken for field blanks.

For any problem or question, you can call UCD's General Lab's main number at 530-752-1123. However, if you've already dealt with a technician and would like to continue dealing with the same person, feel free to call that person directly.

For questions regarding blue boxes, call Anthony Kawamoto at 530-754-8770, or Eric Harvey at 530-752-4905. For technical problems, call Joe Xie at 530-752-4186, or Kevin Goding at 530-752-1123. For further detail, call Jose Mojica at 530-752-9044.

Filters cycle through several processes before they reach the monitoring site and after they return to the University of California-Davis.

## Pre-Shipping ...



**1.** Clean A and D module filters are pre-weighed on a balance before shipping the blue box. Clean B and C module filters are simply placed in a cassette without being weighed. This process is called uploading.

**2.** The uploader weighs the A and D filters. Each filter has an ID according to the site to which it will be sent, and the date that the filter will be used. Each A and D filter's weight is automatically recorded in a database.

**3.** After the box has been uploaded, the work is double-checked. This is the final process before the box is shipped out.



**6.** The B and C filters are placed in a petri dish with the corresponding identification sticker.



**7.** The B and C petri dishes are placed in trays in a particular order generated by the database.



**8.** After the B and C filters are downloaded, the box moves on to the post-weighing station where the sampled A and D filters are weighed.



**9.** After post-weighing, the filter is stored in a pre-labeled slide mount for later analysis.

## Receiving ...



**4.** After the log sheets and flashcards are removed from the box, the data in the flash card is read and automatically placed into a database.



**5.** After the flash card is read into the database, its data is compared to the data written on the log sheets. Any problems a box might have are dealt with at this point.



**10.** After downloading the B and C filters and post-weighing the A and D filters, the box is placed back at the uploading station to start the process again.

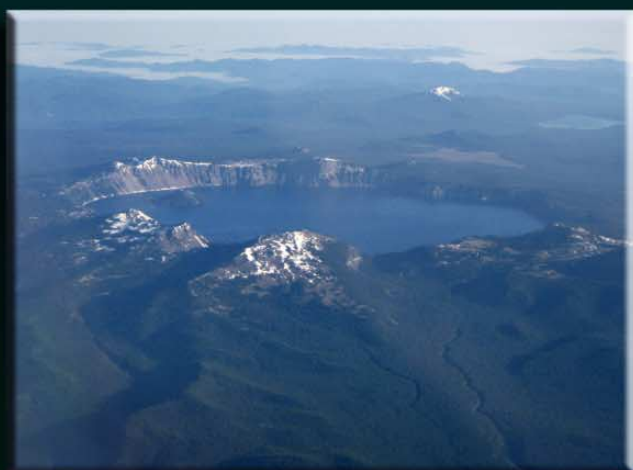


## Crater Lake National Park, Oregon

Chris Wayne is the GIS analyst at Crater Lake National Park. He manages to fit his IMPROVE duties in between making maps, skiing, and hiking. Fortunately, the monitoring site is above his office at park headquarters, on the third floor of the Natural Resources Bldg. During the brief summer, the site towers above the parking lot. During much of the winter, however, you can step out the window and land on snow. CLNP receives about 40 feet of snow during the year, of which 12-20 feet are on the ground at any given time. Chris and his wife Wendy, also an NPS employee (in the orange parka above), enjoy skiing and snowshoeing during the long but beautiful winters here.



The aerial photo below was taken on the summer solstice of 2007, when Chris was flying across Oregon to his home state of Indiana for a wedding - a reminder of why one should always carry a camera when flying in a window seat.



# March

"To waste, to destroy our natural resources, to skin and exhaust the land instead of using it so as to increase its usefulness, will result in undermining in the days of our children the very prosperity which we ought by right to hand down to them amplified and developed." - Theodore Roosevelt, 1907

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
<b>1</b> <i>60 Julian day</i> Yellowstone Natl. Park established, 1872	<b>2</b> <i>61</i> IMPROVE particle sampling day	<b>3</b> <i>62</i> Change IMPROVE particle cartridges.	<b>4</b> <i>63</i>	<b>5</b> <i>64</i> IMPROVE particle sampling day	<b>6</b> <i>65</i>	<b>7</b> <i>66</i>
<b>8</b> <i>67</i> Daylight Savings Time Begins IMPROVE particle sampling day	<b>9</b> <i>68</i>	<b>10</b> <i>69</i> Change IMPROVE particle cartridges.	<b>11</b> <i>70</i> IMPROVE particle sampling day	<b>12</b> <i>71</i>	<b>13</b> <i>72</i>	<b>14</b> <i>73</i> IMPROVE particle sampling day
<b>15</b> <i>74</i>	<b>16</b> <i>75</i>	<b>17</b> <i>76</i> St. Patrick's Day IMPROVE particle sampling day Special IMPROVE particle change. Move cassette 3 from old cartridge to new.	<b>18</b> <i>77</i>	<b>19</b> <i>78</i>	<b>20</b> <i>79</i> Spring begins IMPROVE particle sampling day	<b>21</b> <i>80</i>
<b>22</b> <i>81</i>	<b>23</b> <i>82</i> IMPROVE particle sampling day	<b>24</b> <i>83</i> Change IMPROVE particle cartridges.	<b>25</b> <i>84</i>	<b>26</b> <i>85</i> IMPROVE particle sampling day	<b>27</b> <i>86</i>	<b>28</b> <i>87</i>
<b>29</b> <i>88</i> IMPROVE particle sampling day	<b>30</b> <i>89</i>	<b>31</b> <i>90</i> Change IMPROVE particle cartridges.	UC Davis: <u>Sampler</u> : General Lab (530) 752-1123  ARS: <u>Optical</u> : Carter Blandford or Karen Rosener <u>Photography</u> : Karen Fischer (970) 484-7941			

Feb 2009						
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Operator Involvement -- The Key to Network Success



# Of Interest to Operators



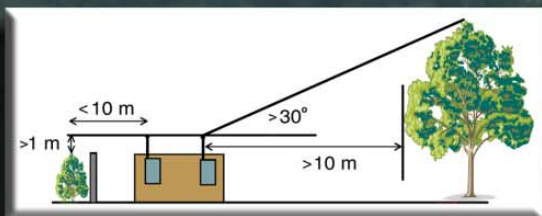
Three possible sampler mounting configurations.

The IMPROVE field operations benefit from an understanding of the audit findings process. This outline of issues was identified during audits conducted in 2005 and 2006. It includes only those issues that are under the control of the site operator. By being aware of these potential problems, we have an opportunity to improve the overall quality of the data and field operations.

## Site Conditions

- ◆ Siting issues - generally a tree that has grown beyond the acceptance criteria
- ◆ Melting ice that is directly impinging on the tops of sampler module boxes

The site must not have large obstructions such as trees or buildings that would hinder the sampling of regional representative aerosols. If necessary, the sampler can be placed on a platform to clear obstructions or to stay above snow pack.



## Safety Issues

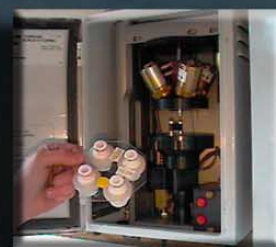
- ◆ Inadequate railings (for example, where icy boards are used to get to modules)
- ◆ Inadequate space to service samplers and modules
- ◆ Electrical connections (temporary extension cords) exposed to wet conditions or in standing water (should be permanent service with GFCI protection)
- ◆ Vermin such as venomous spiders and snakes



Marsh grass, poisonous snakes, and downed power lines fill the scene at the Breton Island site in the aftermath of hurricanes Gustav and Ike in 2008.

## Operator Errors -- Make sure filters are handled with proper procedures.

The first step in correctly diagnosing and solving any problem is to call the General Lab at the University of California, Davis (UCD) at 530-752-1123. No problem is too small, and a correct diagnosis is more likely to be made.



- ◆ Keep filter side down when loading and unloading, and cap the cassettes immediately upon removal.
- ◆ If cartridge is dropped, report on the Field Data Sheet. The cartridges are well protected, and unless the operator is physically forcing air through the media, there should be no immediate problem. Pay careful attention to any fluctuation in the normal readings on that particular set of filters.
- ◆ If the filter gets wet, it can significantly affect the sample. UCD may or may not be able to send a replacement. Call the lab so the problem can be dealt with properly and note it on the logsheet.
- ◆ Module and controller boxes should be kept clean.
- ◆ Wait and verify that the controller recognizes the memory card and states that everything is OK before walking away. When the card is good it's not a problem, but when the controller does not read it, it may lock the system and not sample for the entire week.

## Missed changing filters on the regular Tuesday?

Call the lab and ask about alternate "safe" change dates if you cannot be there on a Tuesday.

Call immediately to get instructions before proceeding with the sample change. Experienced operators should still call UCD to advise of any deviation in the sample changing schedule.

- ◆ If there are remaining sampling days in the week, remove the exposed filters as would normally be done and put in the clean filters that were to have been installed on the last change day. Make a note on the logsheet.
- ◆ If the week is completely missed, remove the exposed filters as would normally be done, but do not put in the filters for the missed change day. Keep these in the shipping box and send them back to UCD when both weeks in that box have passed. Install the appropriate filters for the current week. Make a note on the logsheet of the filters that were not installed.

## Operator Observations

- ◆ Insect infestations in spring and summer, e.g., mud daubers in the sampler inlet, flies in the module or released from cassette upon removal, and spider webs. Inspect sampler inlets every 3 months.
- ◆ Rodent infestation in fall and winter, with wires and tubing checked for damage.
- ◆ Calibration plug seated (at bottom of T-fitting where the inlet tube enters) in every module, checked at each filter exchange.
- ◆ Temperature checked at each setup to assure it is within 10°C of outdoor temperature
- ◆ Clocks should be reset when they vary by  $\pm 5$  minutes or more from a cell phone.
- ◆ In November, December, and January, operators should call UC Davis (530-752-1123) to properly determine how the holidays will affect their sample change schedules in order to not lose samples.



Old inlets became clogged with insect debris.



A new inlet design was easier to clean but still clogged occasionally.



A retrofit screen was installed in 2007/2008.

## Regional Haze Rule Requirements

A "complete" site has, for channels A, B, C, and D,

- ◆ 75% annual recovery,
- ◆ 50% recovery in each quarter, and
- ◆ no more than 10 consecutive sampling periods missing.

In 2007, seven sites failed the completeness test. Sample recovery (for all channels) was about 92%. Reasons for the 8% sample losses included

- ◆ 32% equipment problems,
- ◆ 26% operator no show,
- ◆ 18% power outages,
- ◆ 12% incorrect filter cassette installation,
- ◆ 12% torn or damaged filter.



## Pinnacle State Park, New York

John Spicer has been operating the Pinnacle site in Addison, New York on a full-time basis since the spring of 1999.

The site is one of two rural ongoing research sites in upstate New York that are part of the Atmospheric Sciences Research Center at the State University of New York, Albany. It also contributes data to the New York State Dept. of Environmental Conservation air quality monitoring network.



At an elevation around 1750 ft. above sea level, Pinnacle State Park overlooks the Canisteo River valley, which provides a magnificent backdrop for the 9-hole golf course at the park. On a clear day, visibility is about 15 miles looking west over the valley or east toward Corning, New York. The location is often downwind of the Ohio River valley and the industrial Midwest, and offers an opportunity to contrast the relatively clean 'local' air vs. the polluted air that has aged about a half day during transport from industrial sources.

Measuring pollutants at the site helps quantify the transported contribution of air pollution in eastern cities, and also provides real-time air monitoring data for federal and state networks. IMPROVE provides data for comparison studies and evaluations of different methods and measurements, and has helped establish an ongoing record of particulate mass concentrations.



John served in the U.S. Air Force for 4 years in Lubbock, Texas. He has an A.A.S. degree in chemical technology from Alfred State College, New York and a B.S. degree in chemistry from Texas Tech, and is a certified medical technologist. He spent about 16 years working in medical research and hospital labs throughout the U.S. before taking the position at Pinnacle. John enjoys hiking the trails in the park and snowshoeing in the winter. His favorite pastime is playing guitar in a band with his wife and five close friends in his hometown of Wellsville, New York, where he resides with his wife, step-daughter, three Labrador retrievers, and two cats. He has three grown sons and a baby granddaughter, and is a very active and proud member of the Wellsville Lions Club.



# April

"U.S. consumers and industry dispose of enough aluminum to rebuild the commercial air fleet every three months; enough iron and steel to continuously supply all automakers; enough glass to fill New York's World Trade Center every two weeks" - Environmental Defense Fund advertisement, Christian Science Monitor, 1990

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◆ Check for insect infestations in spring and summer (e.g., mud daubers in sampler inlet and spider webs).

◆ Check for melting ice on tops of sampler modules.

Operator Involvement -- The Key to Network Success



# Operator Support

**A**ir Resource Specialists, Inc. (ARS), supports visibility-monitoring networks for federal land management agencies, state agencies, municipalities, Indian nations, and private industry. ARS currently supports over 75 visibility monitoring sites nationwide and has been the prime contractor to the IMPROVE program, and the National Park Service and Forest Service visibility monitoring and data analysis programs.

ARS strongly encourages operators to call if there are any questions about parts, supplies, or instrument operations. It may be wise to call for instructions and troubleshooting advice before attempting to solve any problems. For questions or problems with IMPROVE sites, call 800-344-5423. For issues concerning special studies or non-IMPROVE sites, call 970-484-7941.



*Carter Blandford, senior data analyst, performs data collection and validation, and provides operator support for transmissometers and nephelometers.*



*Karen Rosener, data analyst, performs data collection and validation, and provides operator support for transmissometers and nephelometers.*



*Karen Fischer, photographic specialist, performs image collection and system trouble-shooting, and provides operator support for photographic systems.*



*Marty Mills, electronics technician, performs servicing of transmissometers and nephelometers and troubleshooting of power-related instrument problems.*

**T**he University of California, Davis (UCD) supports the particulate measurements network for the IMPROVE program. The network of samplers provides aerosol data for the federal, tribal, state, and local agencies. UCD supports over 180 monitoring sites nationwide, including processing over 6,000 filters each month. Handling large volumes of filters and associated data requires carefully designed operating procedures that minimize errors between site operators and UCD. As with any well-crafted plan, things can go wrong and that is where UCD's operator support staff steps in to help.

For any problem or question, you can call UCD's General Lab's main number at 530-752-1123. However, if you've already dealt

with a technician and would like to continue dealing with the same person, feel free to call that person directly.

For questions regarding blue boxes, call Anthony Kawamoto at 530-754-8770 or Eric Harvey at 530-752-4905. For technical problems, call Joe Xie at 530-752-4186 or Kevin Goding at 530-752-1123. For further detail, call Jose Mojica at 530-752-9044.



*Lowell Ashbaugh  
Analytical and Support*



*Steve Ixquiac  
Data Support*



*Jose Mojica  
Lab Supervisor,  
Operator/Data/Field Support*



*Brian Perley  
Analytical Support*



*Eric Harvey  
Operator and Field Support*



*Tetsuya (Anthony) Kawamoto  
Operator and Field Support*



*Alex Roth  
Equipment and Field Support*



*Xiaosen (Joe) Xie  
Operator and Field Support*



*Kevin Goding  
Operator and Field Support*



# Organ Pipe Cactus National Monument, Arizona



Charles Conner operates the IMPROVE station at Organ Pipe Cactus National Monument in southwestern Arizona on the border with the state of Sonora, Mexico. Primarily, he is a field technician in the Ecological Monitoring Program, where he observes, measures, and records everything

from bats to snakes, as well as maintaining a dozen automated weather stations at Organ Pipe and in the sister park of El Pinacate in Sonora. He speaks Spanish and loves being on the border with Mexico, with endless opportunities for exploration in the desert and the Gulf of California.

Organ Pipe Cactus Natl. Mon. is a wonderland in the northern Sonoran Desert, with big cacti, rugged mountains, and endless valleys ribbed with verdant tree-lined washes. Temperatures range



from 20° to 116° F. The summer monsoon storms and their lightning are exciting and refreshing, even with the flash floods. The area has a high diversity of plants and interesting reptiles, and some of the most interesting insects to be found in North America. The desert is a fascinating story of adaptation by plants, animals, and humans.

Organ Pipe generally enjoys clear skies, but activities on the Mexican border such as field and garbage burning, pesticide use, and truck traffic on dirt roads affect air quality. New industrial and urban developments are planned in the local border town of Sonoyta, Sonora, and increasing tourist and truck traffic through the monument also has the potential to increase air pollutants.

The area is sometimes affected by regional haze from Phoenix, urban southern California, the industrialized Gulf coasts of Mexico and Texas, and the smelter regions of Arizona and New Mexico.



# May

"You go into a community and they will vote 80 percent to 20 percent in favor of a tougher Clean Air Act, but if you ask them to devote 20 minutes a year to having their car emissions inspected, they will vote 80 to 20 against it. We are a long way in this country from taking individual responsibility for the environmental problem."  
- William D. Ruckelshaus, former EPA administrator, New York Times, 30 November 1988

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Operator Involvement -- The Key to Network Success



# Current Status of the State Implementation Plans

Bruce Polkowsky, National Park Service, Air Resources Division, Lakewood, CO

In 1999, the Environmental Protection Agency (EPA) issued regional haze regulations that require every state, the District of Columbia, and the U.S. Virgin Islands to incorporate 10-year plans to improve visibility at mandatory federal Class I areas affected by human-caused air pollution from within their borders into their general State Implementation Plans (SIPs) for air pollution control. To allow for monitoring of a "baseline" period from 2000 to 2004 and coordination with emissions reduction strategies needed to meet health standards and other Clean Air Act programs, Congress established December 17, 2007, as the submittal deadline for regional haze plans. In 1999, EPA established Regional Planning Organizations (RPOs) and supported them through grant money to facilitate interstate consultation on technical and policy issues that would arise in individual SIP development.

The Clean Air Act requires that states consult with the federal land managers (FLMs) before completing their public review of the Regional Haze SIPs. Within the Department of the Interior (DOI), the

the states to explain their decisions in response to FLM consultation comments when the SIPs are submitted to the EPA for approval.

## Status

As of August 5, 2008, the DOI received draft SIPs from 23 states. The DOI has also received information related to Best Available Retrofit Technology (BART) permits from seven additional states. BART is a major component of the regional haze rules that requires retrofitting of pollution control equipment on major industrial sources of a certain age and size if those sources are found to contribute to regional haze at any Class I area. More information on the status of the DOI's review is contained in the graphics below.

## SIP Contents

Generally the states have done a good job of describing the status of visibility at the Class I areas for the baseline period of 2000 through 2004. The characterization of visibility and the aerosols that degrade visibility is now well documented through the IMPROVE network and studies using that data conducted by the RPOs.

The SIPs from all states with Class I areas reviewed so far show some progress in improving the 20% worst days in the baseline period, which is the metric established by the Regional Haze Rule. The EPA requested that states compare the progress declared in the SIP with a "uniform" rate of progress that would return Class I area visibility to estimated "natural" conditions by 2064. Many of the states in the East were able to demonstrate that anticipated progress would meet or exceed the "uniform" rate of progress, due to expected reductions in sulfur dioxide emissions from coal-fired power plants under the EPA's Clean Air Interstate Rule (CAIR). The outcome of these SIPs is now in question since legal action in July 2008 struck down CAIR. The EPA will need to address the adequacy of the SIP submitted so far and work with states that have not yet submitted as to how to address utility emissions in the regional haze SIPs. In the West, the visibility conditions today are much closer to "natural" and there is no single aerosol type that is dominant for the worst 20% days. Wildfire also contributes significant impairment at most western Class I areas. The western states are focusing on reductions from electric utilities, the federal mobile source programs, and some modest improvements from smoke management and area source rules. So far, the Class I areas in the West are not expected to achieve the "uniform" rate of progress as established by EPA guidance. This may be due to many factors, including the current assumptions regarding wildland fire and dust estimates used to determine "natural" conditions. The Regional Haze Rule allows for continued assessment of "natural" conditions as the program matures and future SIP revisions are implemented.

The DOI is focusing a lot of resources on getting a complete review of BART sources in this first round of SIPs since retrofitting those older sources are usually the most cost-effective means for making progress in improving visibility for all areas of the country.

## Conclusion

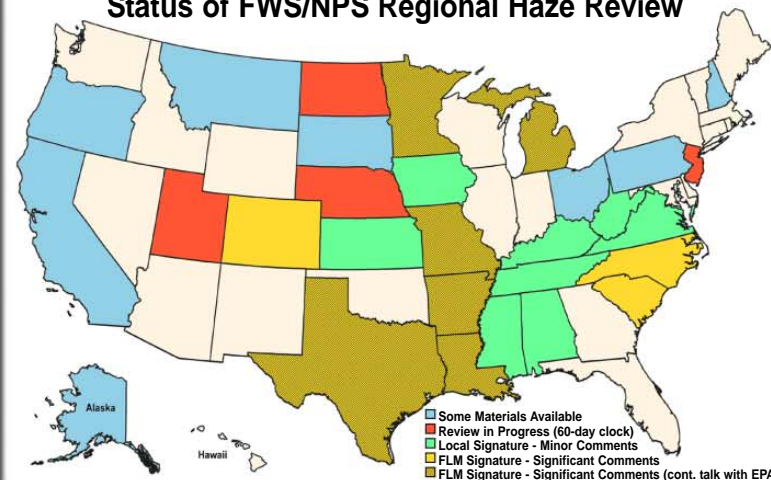
While the timing of SIP development and implementation has been delayed, the DOI is pleased with the efforts of the states to address visibility at Class I areas in a comprehensive way for the first time.

## Regional Planning Organizations

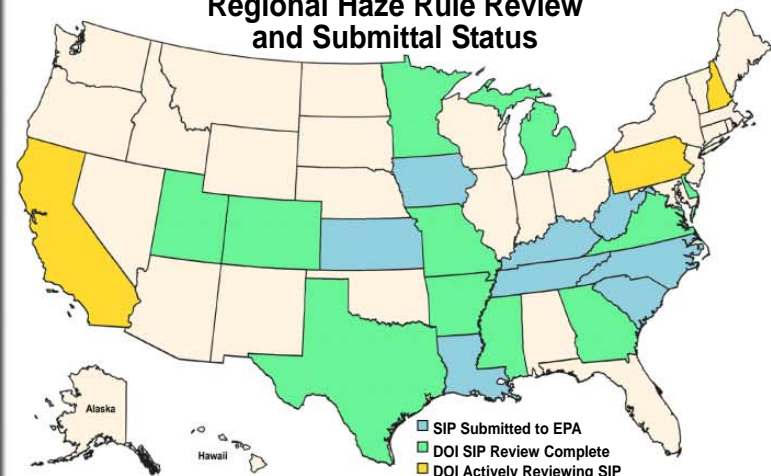


Assistant Secretary for Fish and Wildlife and Parks is the official federal land manager for the 70 Class I areas managed by the National Park Service and the U.S. Fish and Wildlife Service. The review of the SIPs is performed by staff at the National Park Service Air Resources Division and the U.S. Fish and Wildlife Branch of Air Quality, collocated in Lakewood, Colorado. These offices have coordinated efforts to review all the materials provided by the states and avoid duplication of effort. Comments are either sent directly from these offices or, when significant issues are found with a state's approach, comments are sent for signature by the assistant secretary. By law the states must inform the public of FLM concerns as part of the public review of the SIP revisions. The EPA requires

## Status of FWS/NPS Regional Haze Review



## Regional Haze Rule Review and Submittal Status





# Crescent Lake National Wildlife Refuge, Nebraska



Site operator *Charley Chadwick* works in maintenance and equipment operation at Crescent Lake Natl. Wildlife Refuge. Charley spends a lot of his free time tinkering on his own equipment at home, but when he really needs a break, he and his wife, Barb, jump on his Harley and hit the road!



Crescent Lake National Wildlife Refuge lies on the southwestern edge of the Nebraska sandhills, the largest sand dune area in the Western Hemisphere. The sandhills are characterized by rolling, vegetated hills and interdunal valleys. Many shallow lakes and marshes are interspersed in the lower valleys. Native grasses predominate.



The staff at Crescent Lake NWR work toward habitat management that increases wildlife diversity and abundance. Wildlife diversity includes mule and white-tailed deer and dozens of species of grassland birds.

Crescent  
Lake NWR  
Headquarters



Residents  
and  
Visitors



# June

"As we watch the sun go down, evening after evening, through the smog across the poisoned waters of our native earth, we must ask ourselves seriously whether we really wish some future universal historian on another planet to say about us: 'With all their genius and with all their skill, they ran out of foresight and air and food and water and ideas,' or 'They went on playing politics until their world collapsed around them.'"

- U Thant, speech, 1970

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
<ul style="list-style-type: none"> <li>Check for insect infestations throughout the summer (e.g., mud daubers, flies, spider webs).</li> <li>Watch for lightning damage during the summer.</li> </ul>	<b>1</b> 152 Julian day	<b>2</b> 153 Change IMPROVE particle cartridges.	<b>3</b> 154 IMPROVE particle sampling day	<b>4</b> 155	<b>5</b> 156 National Trails Day	<b>6</b> 157 IMPROVE particle sampling day
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<b>28</b> 179	<b>29</b> 180	<b>30</b> 181 IMPROVE particle sampling day Special IMPROVE particle change. Move cassette 3 from old cartridge to new.	UC Davis: <u>Sampler:</u> General Lab (530) 752-1123  ARS: <u>Optical:</u> Carter Blandford or Karen Rosener <u>Photography:</u> Karen Fischer (970) 484-7941			

May 2009						
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Operator Involvement -- The Key to Network Success



# Regional Impacts of Oil and Gas Development in the Western United States

Marco Rodriguez, Michael Barna, Tom Moore,  
Cooperative Institute for Research in the Atmosphere, Colorado State University, Ft. Collins, CO

High ozone levels at the earth's surface are usually associated with photochemical smog and are typically assumed to be an urban air quality problem. In recent years there has been a rise of tropospheric ozone in remote regions of the western United States. Ozone ( $O_3$ ) is a strong oxidant that can harm human health at relatively low concentrations. Recently, the U.S. Environmental Protection Agency (EPA) tightened existing National Ambient Air Quality Standards (NAAQS) for ozone from 80 to 75 ppb. Many medical experts assert that an ozone standard between 60 and 70 ppb is required to protect human health.

Ozone is formed through a complex series of chemical reactions involving nitrogen oxides ( $NO_x$ ) and volatile organic compounds (VOCs) in the presence of sunlight. To combat rising ozone levels, these precursors must be reduced. As oil and gas development in the western U.S. continues to accelerate, there is significant potential that emissions will add to the existing ozone problem. Although emissions from oil and gas development may appear small when compared to other emission sources like coal-fired power plants and automobiles, they typically occur in remote regions of the country and can have disproportionate effects on air quality in rural regions.  $NO_x$  emissions from an internal combustion engine at a gas well may react with terpenes (a reactive VOC) emitted from pine forests forming ozone in an area where, previously, the right mix of precursors was not available for this reaction to take place. Recent observations indicate that many remote wilderness areas and national parks are confronted with ozone concentrations trending toward the EPA's acceptable limits. Northwestern New Mexico and southwestern Colorado are currently seeing rapid growth in oil and gas extraction operations, and there is little understanding of the potential negative impact on air quality in these remote areas.

To investigate this issue, CIRA and National Park Service (NPS) scientists are using sophisticated meteorological and air pollution models to simulate air quality in the western U.S., and determining which emission sources (e.g., oil and gas development, power plants, automobiles) contribute significantly to the pollution burden in our protected remote areas. The concept of "one-atmosphere" is employed to investigate issues related to regional formation and transport of air pollutants such as ozone and particulate matter, impacts on visibility protection, and mitigating health and ecosystem effects due to excessive nitrogen deposition and toxic air pollutants such as mercury.

## Components of the Modeling System

- ◆ **MM5 (Mesoscale Model 5):** A regional weather model that provides the wind fields that CAMx needs to determine the transport of chemical species, as well as other meteorological variables such as temperature and mixing height.
- ◆ **CAMx (Comprehensive Air Quality Model with Extensions):** A chemical transport model that simulates the emissions, dispersion, chemical reactions, and removal of pollutants in the troposphere. This type of simulation accounts for the complex physical and chemical processes that govern the fate of pollutants.

◆ **Pollutant emissions inventory:** A detailed emissions inventory focused on pollutants important for regional haze and visibility that covers the model domain, which includes the contiguous U.S., southern Canada, and northern Mexico, and specifies the hourly flux of emissions from numerous area and point pollutant sources. The inventory consists of 22 emission categories (e.g., automobiles, power plants, forest fires, oil and gas development) and was developed for the Western Regional Air Partnership (WRAP).

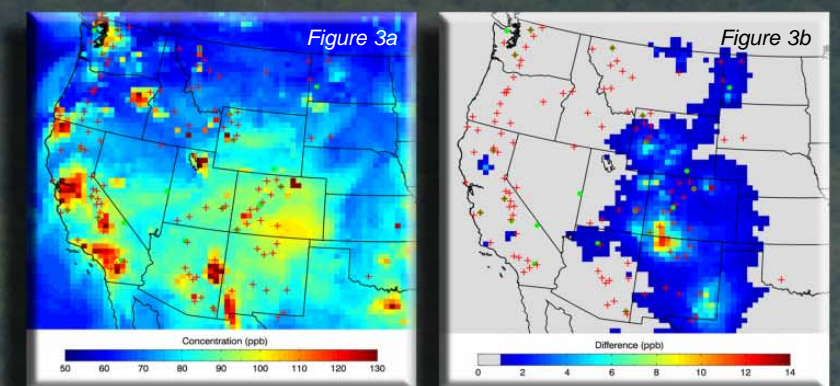
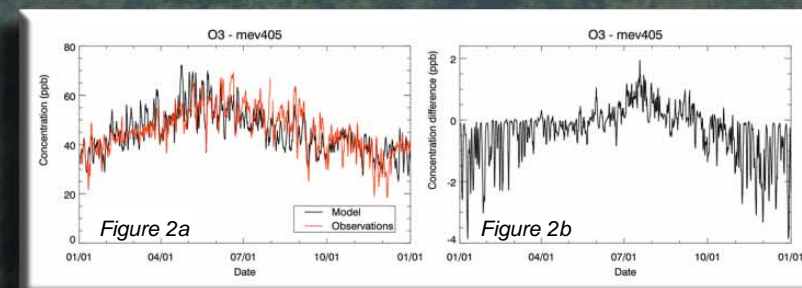
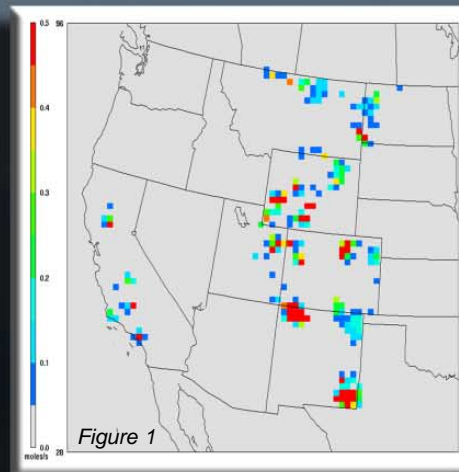
Figure 1 shows typical  $NO_x$  emissions associated with oil and gas development in the western U.S. from the 2002 WRAP emissions inventory. Note the significant emissions that occur throughout the Intermountain West, and in particular the four corners region of northwestern New Mexico.

The oil and gas emission inventory used in this study was initially compiled for the WRAP's regional haze simulations, with a focus on  $NO_x$  and oxidized sulfur ( $SO_x$ ) emissions, which are precursors to fine particulate nitrate and sulfate. The general trends presented here give a gross indication of the impact of this source category on regional ozone formation. For this study, the largest impacts from oil and gas emissions on regional ozone were seen near Mesa Verde National Park. This is not surprising, given its proximity to the extensive development that is occurring in northwestern New Mexico.

Figure 2a shows the predicted (black) and observed (red) ozone concentrations for Mesa Verde National Park, and Figure 2b illustrates the change in ozone concentration attributed to oil and gas emissions at this site. As expected, the general trend of both predicted and observed ozone is low concentrations during the colder winter months, when limited photochemistry will occur, and higher concentrations during the

warmer late spring and summer months, when meteorological conditions are more favorable to ozone production. In addition, it is anticipated that enhanced biogenic VOC emissions occurring during the spring and summer will further influence ozone formation in this region.

A regional perspective of ozone formation is illustrated in Figure 3. Figure 3a shows the peak estimated ozone concentration at each model grid cell that occurred during the 2002 base case simulation. As expected, there are high concentrations downwind of major urban areas such as Los Angeles, San Francisco, Salt Lake City, and Denver. There are also large ozone peaks in the more remote regions of Nevada, Wyoming, Utah, Arizona, New Mexico, and Colorado. These maxima occur during hot days with light winds in the summer, when the meteorology is most favorable for ozone production. These periods also typically correspond to peak VOC emissions from biogenic and anthropogenic sources. The role of  $NO_x$  and VOC emissions from oil and gas development on ozone in the western U.S. is shown in Figure 3b. The peak simulated ozone for each grid cell during 2002 is shown, but in this case the ozone concentration is due solely to emissions from oil and gas development. Although the peak ozone maxima throughout the West are typically quite small, there is a strong signature of a 2-3 ppb of ozone throughout New Mexico, Colorado, and Wyoming, with a pattern that approximates the emissions shown in Figure 1. In addition, significant ozone concentrations exceeding 10 ppb are evident in southwestern Colorado and northwestern New Mexico. Class I areas in this region that are likely to be impacted by increased ozone include Mesa Verde National Park and Weminuche Wilderness Area in Colorado, and San Pedro Parks Wilderness Area, Bandelier Wilderness Area, Pecos Wilderness Area, and Wheeler Peak Wilderness Area in New Mexico.



This study indicates a clear potential for oil and gas development to negatively impact regional ozone concentrations in the western U.S., including several treasured national parks and wilderness areas in the Four Corners region. It is likely that accelerated energy development in this part of the country will worsen the existing problem. These simulations will be refined with the updated emission inventories available from the WRAP. Regional air quality modeling remains the only feasible option for developing emission control strategies.



# Shining Rock Wilderness Area, Pisgah Natl. Forest, North Carolina



David Finnan (right) is the primary operator for the Shining Rock IMPROVE site in North Carolina, and is assisted by Wade Carpenter (left) and Barry Wilkinson (center). David's duties in the Pisgah Ranger District include working as a wilderness ranger, working in dispersed recreation, and being a Wildland Firefighter Type I. He has worked for the U.S. Forest Service for 7 years, starting as a primary firefighter in 2001 on the Grandfather Ranger District in Nebo, North Carolina. His current wilderness ranger position in Pisgah Natl. Forest began in March 2006. He enjoys helping collect data that may possibly change the way we look at things as a society. He has a wife and a 13 year-old daughter. He likes being with his family and watching his daughter play sports.

The IMPROVE site is on Frying Pan Mtn., just off the Blue Ridge Parkway, near milepost 408. Frying Pan offers spectacular views of Shining Rock Wilderness, especially the northern end which culminates in the 6,030-foot-high Cold Mountain -- the same mountain made famous by Charles Frazier's Pulitzer Prize-winning novel. Shining Rock is the largest wilderness area in the state, encompassing 18,483 acres. It was designated a Class I area in 1964. It is comprised of a series of high ridges and steep forested slopes, nurtured by abundant rainfall. As with many areas in the southern Appalachians, Shining Rock is well known for its rich and diverse biota.

Originally this area was a part of the Cherokee Nation, but with the 1796 North Carolina land grant, settlers soon arrived. By the early 20th century the area was heavily logged and burned. Today the slopes are once again covered with mature forests of an amazing diversity. Shining

Rock itself, named for the white quartzite rock that forms its summit, is an extremely popular destination for hikers and campers year round. Current weather data and web cam views of Cold Mtn. can be found at <http://webcam.srs.fs.fed.us/>.



# July

"A human being is part of the whole, called by us "Universe," a part limited in time and space. He experiences himself, his thoughts and feelings as something separated from the rest - a kind of optical delusion of his consciousness. This delusion is a kind of prison for us, restricting us to our personal desires and to affection for a few persons nearest to us. Our task must be to free ourselves from this prison by widening our circle of compassion to embrace all living creatures and the whole [of] nature in its beauty." - Albert Einstein, 1950

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Operator Involvement -- The Key to Network Success



# Characterization of Particle Emissions from Laboratory Combustion of Wildland Fuels

Hans Moosmüller, Desert Research Institute, Reno, NV; Sonia M. Kreidenweis, Jeffrey L. Collett Jr., and William C. Malm, Colorado State University, Fort Collins, CO; Wei M. Hao, Fire Sciences Laboratory, Rocky Mountain Research Station, USDA Forest Service, Missoula, MT

Aerosol particles in the atmosphere influence the earth's radiation balance and climate, atmospheric chemistry, visibility, and human health on scales ranging from local to global. On a global scale, direct radiative effects from particles of anthropogenic origin (as opposed to dust entrainment caused by desertification) are dominated by sulfate and carbonaceous particles. While sulfate particles have a very high albedo and predominantly scatter light in the visible part of the spectrum, carbonaceous particles contain components that both scatter and absorb visible light, resulting in a wide range of albedos. Black carbon (BC) is the strongly light-absorbing component, while organic carbon (OC) is mostly light scattering. BC and OC can coexist in internally mixed particles that may consist of a BC core coated with OC. In addition to the direct radiative effects of carbonaceous particles, they can also serve as cloud condensation nuclei (contributing to the indirect climate effect) and assist in the evaporation of clouds due to light absorption and heating by BC (semi direct effect). Transport, deposition, chemistry, radiative effects, and health effects of particles depend largely on their composition, size distribution, and morphology.

Wildland fires of both anthropogenic and natural origin are a major source of carbonaceous particles in the global atmosphere. The properties of aerosol particles emitted by wildland fires vary strongly and are largely determined by fuel properties and combustion conditions. Unfortunately, very little is known about the characteristics of particles emitted from the combustion of wildland fuels as a function of fuels and combustion conditions.

To improve our understanding of the influence of wildland fires on the environment, experiments are being conducted to study the characteristics of aerosol particles freshly emitted from the combustion of individual wildland fuels under controlled laboratory conditions. This study, called FLAME (the Fire Lab at Missoula Experiment), is a cooperative effort between the National Park Service, the Forest Service's Missoula Fire Sciences Laboratory (FSL), the Desert Research Institute (DRI), and Colorado State University, with participation from a number of outside investigators. Experiments are taking place in the FSL Combustion Laboratory with two different modes of operation: 1) stack burns vent all fire emissions through a 17-meter-high stack (see Figure 1) with sampling of the emissions occurring near the top of the stack, with instruments and filter/canister samplers located on the sampling platform at 15 meters height, and 2) chamber burns with fire emissions that fill the whole chamber with smoke.

Stack burns allow for the characterization of the time evolution of fire emissions as the combustion process evolves from flaming to smoldering combustion. Instruments with high time resolution (typically 1 to 5 seconds) enable characterization of particle mass, optical properties (e.g., absorption, scattering, and extinction), and gaseous emissions (e.g., CO<sub>2</sub>, CO, NO<sub>2</sub>, and NO) as a function of time.

Chamber burns store the emissions from the burn in a large room where particles slowly change. Therefore it is possible to use more time-consuming measurements relying on near-constant smoke properties, such

as determining the particle size distribution with a scanning mobility particle sizer.

Specific FLAME objectives include a) determination of fuel-based aerosol particle emission factors, b) characterization of physical and optical properties of aerosol particles and their change as a function of relative humidity conditioning, and c) development of improved chemical smoke tracer profiles and measurement methods.

Initial results include the determination of emission factors for particles and gaseous species emitted during the flaming and smoldering combustion of several wildland fuels, the characterization of particle optical properties and morphology, the change of particle light-scattering as a function of rel-

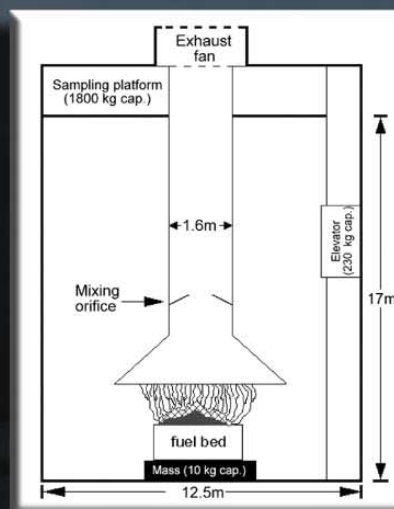


Figure 1. Schematic diagram of the Forest Service's Fire Sciences Laboratory (FSL) combustion facility in Missoula, Montana.



ative humidity, the characterization of organic emissions used as smoke markers, the development and application of an improved detection technique for levoglucosan -- a commonly used smoke tracer -- and an improved understanding of partitioning of mercury emitted from biomass combustion between particulate-phase and gaseous elemental mercury.

One example of the results shows the evolution of particle optical properties (Figure 2), namely absorption, extinction, and single-scattering albedo (indicating the whiteness). During the initial flaming-combustion phase, nearly all extinction is due to absorption, indicating the emission of very black particles (albedo = 0.15), followed by a transition to smoldering combustion, emitting very white particles (albedo > 0.95). The black smoke emitted during flaming combustion consists

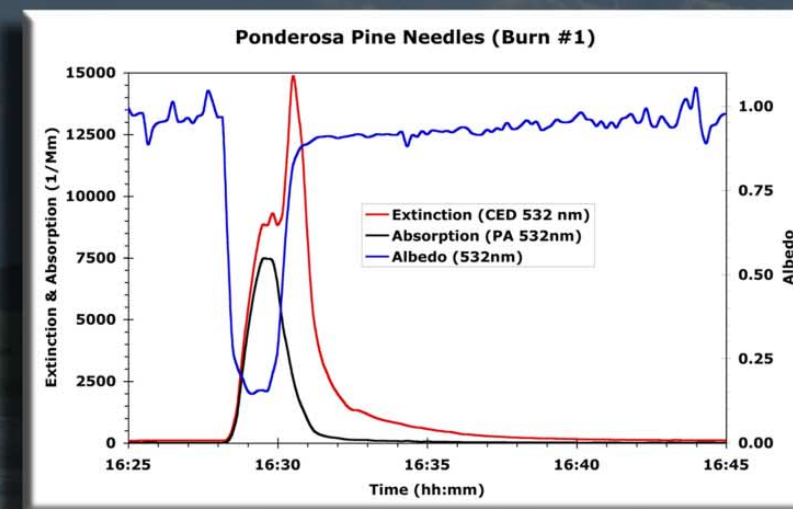


Figure 2. Change in particle optical properties during combustion of Ponderosa Pine needles from flaming to smoldering phase.

largely of fractal-like chain aggregates of strongly light-absorbing BC monomers coated with OC (Figure 3a). Smoldering combustion emits rather white smoke consisting of larger round particles (tar balls) containing mostly OC (Figure 3b). Due to the extremely different physical, chemical, and optical properties of particles emitted from flaming and smoldering combustion and the large variability between fuel consumption by flaming and smoldering, it is very important to separately characterize their emissions and emission factors.

For more information, visit <http://chem.atmos.colostate.edu/FLAME/> or e-mail Hans Moosmüller at the Desert Research Institute, Nevada System of Higher Education, Reno, Nevada, at [hans.moosmuller@dri.edu](mailto:hans.moosmuller@dri.edu).

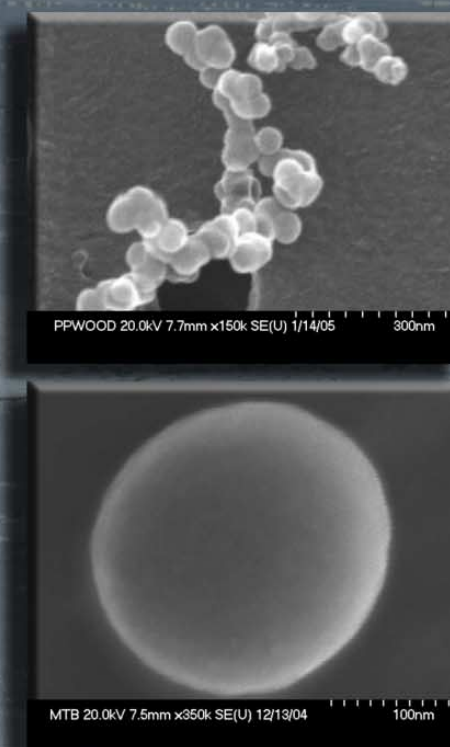


Figure 3. (a) Fractal-like chain aggregates from the flaming combustion of Ponderosa Pine wood; (b) Tar ball from the smoldering combustion of "Montana grass".



## Great Sand Dunes National Park, Colorado



Andrew Valdez is the primary IMPROVE sampler operator at Great Sand Dunes National Park and Preserve. He loves being a geologist at Great Sand Dunes, describing the area as "a dynamic resource that we have learned much about. We have been able to apply this knowledge to management issues such as protection against groundwater development, obtaining a boundary expansion, obtaining protective groundwater rights, and increasing the understanding of the physical system. I've had the opportunity to work with and learn from a wide variety of scientists. Great Sand Dunes is an area that I feel has greatly benefited from the application of science."

standing of the physical system. I've had the opportunity to work with and learn from a wide variety of scientists. Great Sand Dunes is an area that I feel has greatly benefited from the application of science."

This area, scenically located in a high valley around 8000 feet in elevation at the western foot of the Sangre de Cristo Mountains in south-central Colorado, has only recently been named a national park, its status having been upgraded from national monument in 2004. It was then that it was also quadrupled in size. According to the park service, the main dune area, which is only about 30 square miles in area, "contains the tallest dunes in North America, ranging up to 750 feet above the valley floor in one of the most fragile and complex dune systems in the world, and includes creeks that demonstrate surge flow, a rare hydrologic phenomenon; hosts a great diversity of plants and animals, including insect species found nowhere else on earth; and contains some of the oldest known archeological sites in America," dating back to 7000 BC.

Mr. Valdez says that the air quality is generally excellent, with mountains 50 miles away seen with great clarity. Air quality does sometimes degrade in the springtime when strong winds create dust storms, but he adds that there are no notable industrial sources upwind (to the southwest). However, wildfires upwind of the park can greatly impact air quality.



In addition to operating the sampler, Andrew keeps an eye on hydrologic resources. He also studies, monitors, and determines the physical processes that lead to the development of Great Sand Dunes. A self-described TV watcher and "athletic couch potato", he remains single with no kids but evidently has had an interest in nature his entire life. As a child, he was always breaking rocks to see what they looked like inside. Is it any surprise he became a geologist?



# August

"It is imperative to maintain portions of the wilderness untouched so that a tree will rot where it falls, a waterfall will pour its curve without generating electricity, a trumpeter swan may float on uncontaminated water - and moderns may at least see what their ancestors knew in their nerves and blood."

- Bernard De Voto, *Fortune*, June 1947

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
<p>◆ Watch for lightning damage.</p> <p>◆ Check site conditions (e.g., a tree growing beyond acceptance criteria).</p>						<p><b>1</b></p> <p>213 Julian day</p>
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Operator Involvement -- The Key to Network Success



# Ammonia Monitoring, and the Impacts of Oil and Gas Emissions

John V. Molenaar, Cassie Archuleta, and Mark Tigges,  
Air Resource Specialists, Inc., Ft. Collins, CO;  
H. James Sewell, Shell Exploration & Production Co.;  
Florian M. Schwandner and Suresh Raja,  
Dept. of Atmospheric Science, Colorado State University, Ft. Collins, CO



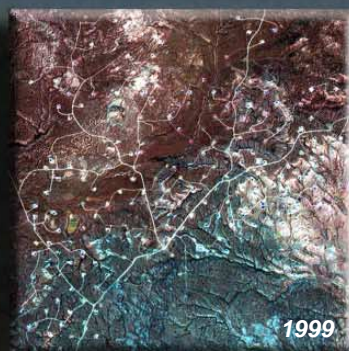
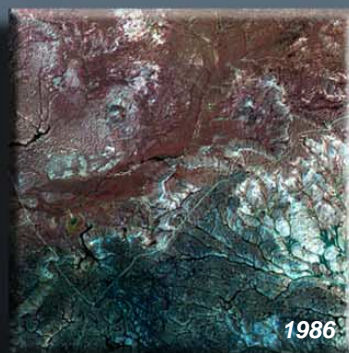
3000 natural gas wells have been drilled. Another 10,000 wells are proposed over the next decade.

Rising energy prices make it lucrative to tap resources here, and proposals are on the table to expand drilling operations and allow significant year-round drilling. There is concern that visibility is being degraded, that winter ranges and migratory pathways are being compromised, and that acid deposition is affecting alpine lakes in Yellowstone and Grand Teton national parks and in nearby wilderness areas. In addition, ambient levels of pollutants like ozone and particulate matter approach the threshold for affecting human health, while nitrogen oxide ( $\text{NO}_x$ ) emissions are three times those anticipated.



## Impacts: Oil & Gas Emissions

Current work addresses concerns about  $\text{NO}_x$  converting to particulate nitrates. The complex nonlinear sulfate-nitrate-ammonia system is highly dependent on availability of ammonia gas. Impacts of oil and gas development include



*Landsat Images showing oil and gas development. In 1986, there was no sign of oil and gas development. The first permits were let and drilling began in 1995-96. By 2007, there is an extensive network of drilling pads, roads, etc.*

- ◆ particulates from roads and disturbed land;
- ◆ VOCs from drilling fluids, separation, dehydration, produced water, gas venting, and gas compression; and
- ◆  $\text{NO}_x$  from diesel drilling rigs, gas compression, vehicles, and flaring.

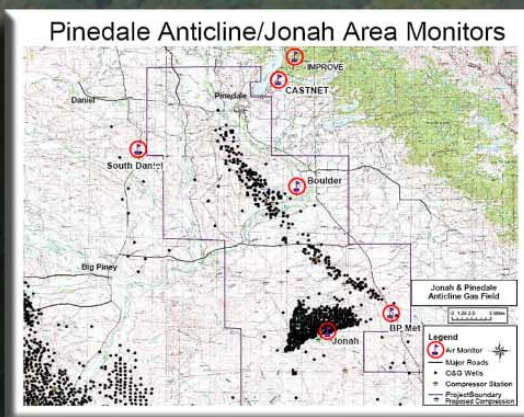
## Monitoring

A long-term ammonia air monitoring study was initiated in December 2006 at Boulder, Wyoming, by Shell Exploration & Production Company. The monitoring site is located in the Upper Green River Basin of western Wyoming, southwest of the Bridger Wilderness, a Class I area with an IMPROVE monitoring site. This region is experiencing rapid development of natural gas resources with possible consequences of air quality and visibility impacts in the Bridger Wilderness. Only very limited short-term ammonia measurements were previously available for this region. The primary objectives of this study were to

- ◆ measure background ammonia ( $\text{NH}_3$ ) concentration for one year for use in refined visibility analyses,
- ◆ measure concentrations of other related gases and particles to provide information about the local nitrogen budget, and
- ◆ attempt to identify the source regions attributable to these gases and particulates.

## Location of existing monitoring sites in the Upper Green R. Basin:

- ◆ IMPROVE
- ◆ CASTNet
- ◆ South Daniel - full AQ
- ◆ Boulder - full AQ
- ◆ Jonah - full AQ
- ◆ BP Met - meteorological only



## Results

Figure 1 (at the top of the next column) shows measured gaseous and particulate concentrations from December 2006 through January 2008. Ammonia is seasonally dependent but peaks in July and August. There are two extreme acid sulfate episodes, one in May 2007, and the second in October-November 2007. Particulate nitrate peaks in the winter.

Figure 2 charts gas/particle partitioning of the measured species (concentrations in  $\text{g}/\text{m}^3$ , top bar stack for particles, bottom bar stack for gases) for the same time period. Particulate sulfate (red) dominates throughout most of the year. Reduced nitrogen (green bars) shows an increased partition-

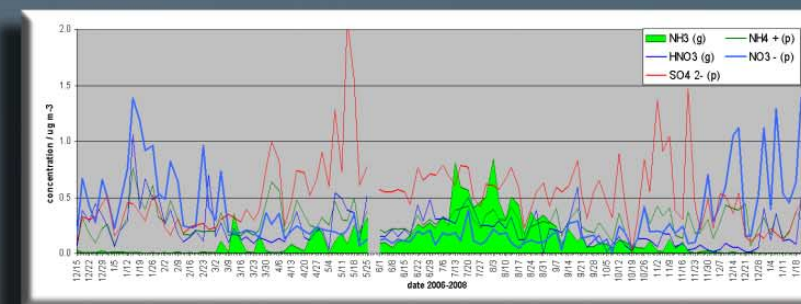


Figure 1

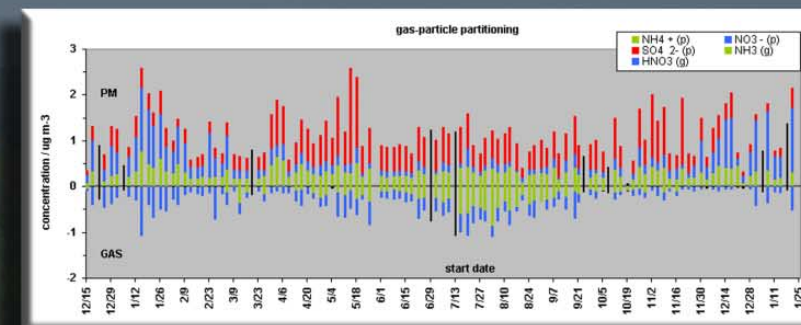


Figure 2

ing into the gas phase (ammonium to ammonia). Increased particulate nitrate in late winter is consistent with thermodynamic expectations: ammonium nitrate formation is favored at lower temperatures and higher relative humidities.

Three events stand out: high particulate nitrate in January, 2007; high particulate nitrate in December 2007 to January 2008; and high particulate sulfate in May 2007. The winter nitrate events are interesting as all reduced nitrogen is present as particle-phase ammonium while considerable nitric acid remains in the gas phase. Sufficient increases in ammonia emissions during this period could have substantially increased fine particle mass concentrations by further ammonium nitrate formation.

## Summary

A 15-month study in the Upper Green River Basin of Wyoming in which ammonia and nitric acid gases and ammonium, nitrate, and sulfate particles were measured has been completed. The results of the study show that in the Upper Green River Basin of Wyoming, 2007 ammonia concentrations are (1) quite variable throughout the year, (2) are below or near detectable limits from December through late February, (3) peak in August at 1.55 ppbv, and (4) have a yearly mean value of 0.24 ppbv. Nitric acid is highest in the winter; if more ammonia was present, it is possible there would be more particulate nitrate formed during these periods.



## Sipsey Wilderness Area, Bankhead National Forest, Alabama



The Bankhead National Forest, located in northwestern Alabama is managed and protected by the Forest Service under the "multiple-use concept," which means managing the forest to provide the optimal blend of all its resources. This includes wood, wildlife, recreation, wilderness, and water.

The Bankhead offers something for everyone. Its 179,000 publicly owned acres include scenic beauty, tall trees, flowing streams, picturesque rock bluffs, and abundant wildlife. The rock cliffs that rise from the waters of Smith Lake and along the canyons of the Sipsey River are outstanding examples of the Bankhead's rugged beauty. Streams on the Bankhead often cascade over rock faces into deep canyons to form beautiful waterfalls.

The main IMPROVE operators are *Nikka Jefferson* (at top), fire dispatch / timber resource support, and *Jeanne Marie Pleva* (directly above), forestry technician / firefighter. Both began their Forest Service career on the Bankhead and are very proud to work in such a beautiful forest.



# September

"Fall is my favorite season in Los Angeles, watching the birds change color and fall from the trees."

- David Letterman

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Operator Involvement -- The Key to Network Success



# ROSES: Research Opportunities in Space and Earth Sciences

NASA Earth Sciences Division, Applied Sciences Program, Air Quality Applications;  
Uma Shankar, Institute for the Environment, The University of North Carolina at Chapel Hill;  
Tom Moore, Shawn McClure, Cooperative Institute for Research in the Atmosphere,  
Colorado State University, Ft. Collins, CO

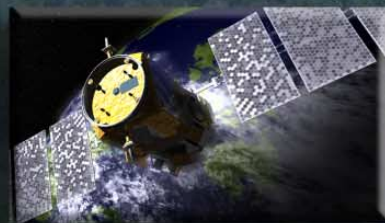
## Improving Air Quality Decision Support Systems through Integration of Satellite Data, Ground-Based IMPROVE Data, and Modeled and Emissions Data

State and local agencies, regional planning organizations, and federal land managers currently use a variety of data sources in urban-to-regional-scale air quality planning to meet the National Ambient Air Quality Standards and address visibility impairment in federal Class I areas.

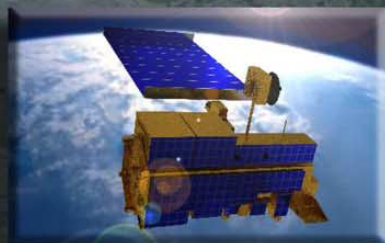
A new project is being funded that incorporates IMPROVE data and NASA remote sensing data from MODIS (Moderate Resolution Imaging Spectroradiometers) and OMI (Ozone Monitoring Instrument), and from GOES (Geostationary Operational Environmental Satellite) and CALIPSO satellites to better characterize pollutants and their sources at ground level and aloft. The goal is to facilitate a more thorough and efficient evaluation of comprehensive three-dimensional air quality models such as the EPA Community Multiscale Air Quality (CMAQ) model used in air quality planning.

The project supports and engages several end user groups, including the Western Regional Air Partnership (WRAP), the National Park Service, the U.S. EPA, and the North Carolina and Utah divisions of air quality. The University of North Carolina leads the project with co-investigators at the Cooperative Institute for Research in the Atmosphere (CIRA) and the University of Maryland, Baltimore County (UMBC).

U.S. air quality is affected by both local emissions and long-range transport of pollutants from other regions. Trans-Pacific transport of pollutants has affected background ozone in the



The **CALIPSO** satellite provides vertical profiles of dust and aerosols in the atmosphere.

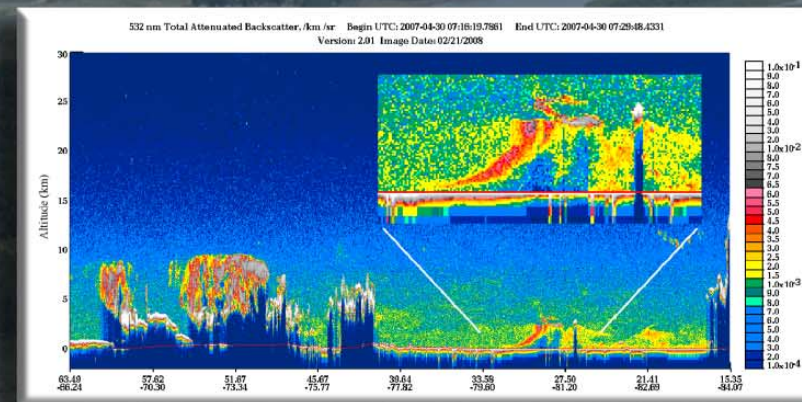


The **Terra/Aqua** satellites supply fire detection products and imagery from MODIS.



Wildfires in Georgia and Florida continue to burn on Friday, May 11, 2007. MODIS sensors on the Terra/Aqua satellites reveal significant aerosol sources affecting air quality.

western U.S., and dust and smoke plumes from China have been seen to reduce visibility in the rural Midwest. States must assess long-range transport vs. local source contributions to prepare effective State Implementation Plans (SIPs) in order to demonstrate compliance with EPA air quality and haze regulations. Integrating modeled and observational data for 3D characterization of air quality is critical to their success.

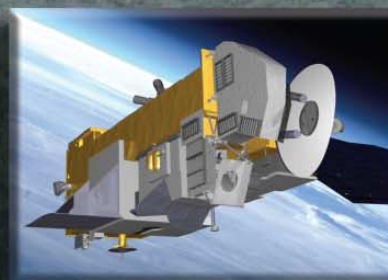


To aid in assessing air quality above the ground, the LIDAR profiles from the CALIPSO satellite tell us where in the vertical the smoke rises. For the Georgia fires in early May 2007, the fires rose quickly (inset) above the ground.

## Project Details

In conjunction with ground-based network data from the IMPROVE program and other monitoring networks, this project applies existing NASA aerosol optical depth products and imagery from the Terra/Aqua (MODIS, AIRS) and Aura (OMI) satellites and the CALIPSO LIDAR, as well as fire activity data from the GOES satellite to provide a more complete picture of the aerosol concentrations and sources over the U.S. Data from multiple networks are currently available in the Visibility Information Exchange System (VIEWS) and the WRAP Technical Support System (VIEWS/TSS). This project seeks to enhance that data set with the improved spatial and temporal coverage of satellite data.

The system will include metadata for air quality planners to use the satellite data in a complementary manner with ground-based observations to understand source characteristics and the composition of particulate matter that most significantly contributes to air



The **Aura** satellite carries instruments to study atmospheric chemistry, including measurements of ozone, carbon monoxide, nitrogen oxides, chloroflourocarbons, and methane.

quality and visibility degradation in a particular region. In addition to satellite data, the enhanced system will include advanced analysis tools to apply and interpret these data in the urban-to-regional scale modeling required to develop state and tribal implementation plans for meeting air quality and visibility standards. Simulations with the CMAQ model will exercise the capabilities of the enhanced system, from input data improvements to analysis and interpretation of the results.

The ability to apply satellite observations to air quality issues stems from decades of investments by NASA and the atmospheric research community in aerosol retrieval methods, sensor technology, validation efforts, and other scientific research. Complementary use of ground-based measurements with satellite data in the project will further enhance the relevance of these research efforts to air quality planning.

## Project Outcomes

Expected outcomes of this project include improvements to

### VIEWS/TSS

- ◆ provide multidimensional aerosol-related data and analyses,
- ◆ expand the analytical capabilities to provide visualization and interpretation of observations compared to air quality model results,
- ◆ assess the general state of air quality and visibility trends,

### CMAQ Model Evaluation

- ◆ interpret model results using the newly available vertical profiles from the satellite data, and
- ◆ identify areas for improvement in process algorithms.

## Value and Benefits

- ◆ Increased reliability in air quality forecasts, to reduce health impacts and visibility degradation due to poor air quality, and to promote healthier ecosystems
- ◆ Increased understanding of source-receptor relationships, leading to defensible and achievable control strategies for decision makers
- ◆ Valuable case studies and precedents for improved rule making

## Key Websites

- ◆ The Visibility Information Exchange Web System:  
<http://vista.cira.colostate.edu/views>
- ◆ Western Regional Air Partnership Technical Support System:  
<http://vista.cira.colostate.edu/views>
- ◆ Infusing satellite Data into Environmental Applications:  
<http://idea.ssec.wisc.edu/>
- ◆ EPA Air Quality System:  
<http://www.EPA.gov/ttn/airs/airsaqs/>



## UL Bend, Sand Creek Wildlife Station, Roy, Montana



Dan Harrell has been the primary operator at the U.L. Bend site on the Charles M. Russell (CMR) National Wildlife Refuge since it was first established. Primarily, he is a habitat biologist. This position includes research and monitoring of sentinel plants and how these plants are affected by grazing and fire. He is also responsible for monitoring the livestock grazing on approximately 175,000 acres of the refuge, and he works with the owners of the cattle to try to keep conflicts to a minimum.

The biggest challenge when this site was first established was finding a back-up operator. Dan lives 55 miles away and cannot be present at all times to take the readings. Paul Pallas, who also works on the wildlife refuge as the assistant fire management officer, reliably operates the station when Dan can't be there.



Visibility is generally pretty good at the site, although there are times during the summer and fall when air quality is significantly reduced by wildfires. There are plans to establish some coal-fired power plants in the state, with at least one in the direction of the prevailing winds for the IMPROVE station. How much that will affect air quality in the future is not known.

Established in 1936 by President Franklin D. Roosevelt as the Fort Peck Game Range, it is now known as the Charles M. Russell National Wildlife Refuge. The refuge extends from Fort Peck Lake, 125 miles up the Missouri River to the west, and contains approximately 1.1 million acres. The mission of the refuge is "to preserve, restore and manage, in a generally natural setting, a portion of the nationally significant Missouri River Breaks and associated ecosystems for optimum wildlife resources."



# October

"The ultimate test of man's conscience may be his willingness to sacrifice something today for future generations whose words of thanks will not be heard."

- Gaylord Nelson, former governor of Wisconsin, founder of Earth Day

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Operator Involvement -- The Key to Network Success



# Ozone Standard Strengthened

United States Environmental Protection Agency,  
Office of Air Quality Planning and Standards  
[www.epa.gov/air/ozone/pollution](http://www.epa.gov/air/ozone/pollution)

On March 12, 2008, the EPA significantly strengthened the National Ambient Air Quality Standards (NAAQS) for ground-level ozone. The law requires the EPA to review scientific information and the standards for ozone and other criteria pollutant every five years. There are two types of ozone standards that can be affected:

**Primary Ozone Standard** -- protects public health, especially those vulnerable populations such as people with lung disease like asthma, children, older adults, and people who risk higher exposure rates, such as outdoor workers

**Secondary Ozone Standard** -- sets limits to protect public welfare, including protection against damage to animals, crops, vegetation, and buildings.

The ozone standards were last revised in 1997. At that time both the primary and secondary standards were set at 0.080 parts per million (ppm) with an 8-hour averaging time.

When **setting** the NAAQS, consideration is given to health and environmental effects. In contrast, **achieving** the NAAQS requires more consideration be given to accounting for cost, technical feasibility, and the time needed to attain the standard.

The EPA has concluded that the 1997 **primary** standard is not adequate to protect public health with an adequate margin of safety. They have strengthened the level of the 8-hour primary ozone standard from 0.080 ppm to 0.075 ppm. More than 1700 new scientific studies indicate strong evidence of adverse health impacts of ozone at the level of the 1997 primary standard and below.

- ◆ Clinical studies show evidence of adverse respiratory responses in healthy adults at a level of 0.080 and possibly lower.
- ◆ Large numbers of new epidemiological studies, including new multi-city studies, strengthen the EPA's confidence in the links between ozone exposure and health effects observed in the last review, including emergency department visits and hospitalizations for respiratory causes.
- ◆ In addition, studies now link ozone exposure to other important health effects, including mortality, increased asthma medication use, school absenteeism, and heart-related effects.
- ◆ Studies of people with asthma indicate they experience larger and more serious responses to ozone that last longer than responses in healthy individuals

The EPA has also concluded that the 1997 **secondary** ozone standard is not adequate to protect the public welfare -- including protection against damage to animals, crops, vegetation, and buildings. They have strengthened the level of the 8-hour secondary ozone standard to 0.075 ppm.

- ◆ Ozone effects on sensitive species include reduced biomass, foliar injury, loss of vigor, and susceptibility to disease. This could lead to loss of plant diversity and change the types of plants in ecosystems.
- ◆ Current ambient concentrations in many areas of the U.S., including areas that reach the 1997 standard, are sufficient to cause adverse impacts.
- ◆ Important new scientific information has been developed since 1997; however many significant uncertainties remain.
- ◆ While the EPA agrees with the Clean Air Scientific Advisory Committee (CASAC) that cumulative, seasonal exposures are the most biologically relevant, the remaining uncertainties over how to best protect vegetation led the administrator to conclude that the secondary standard should be set equal to the primary standard.

## Revised Ozone Air Quality Index (AQI)

The EPA is changing the Air Quality Index (AQI) to reflect the new primary ozone standard. The AQI is the EPA's color-coded tool designed to inform the public about daily air pollution levels in their communities. The EPA is adjusting the 100-level, which is the upper end of the "moderate" category, to equal the new 0.075 ppm standard, and making proportional changes to other AQI values. The EPA encourages the states to use the new AQI break points for air quality forecasting starting on May 1, 2008.

## Benefit and Cost Results

These estimates assume aggressive technological change between today and 2020. In addition to the health benefits of reduced air pollution, the Regulatory Impact Analysis estimates that a standard of 0.075 ppm would prevent the following numbers of additional adverse health effects annually by 2020:

- ◆ 380 cases of chronic bronchitis,
- ◆ 890 nonfatal heart attacks,
- ◆ 1,900 hospital and emergency room visits,
- ◆ 1,000 cases of acute bronchitis,
- ◆ 11,600 cases of upper and lower respiratory symptoms,

Category	AQI Value	1997 8-hour (ppm)	2008 8-hour (ppm)
Good	0-50	0.000-0.064	0.000-0.059
Moderate	51-100	0.065-0.084	0.060-0.075
Unhealthy for Sensitive Groups	101-150	0.085-0.104	0.076-0.095
Unhealthy	151-200	0.105-0.124	0.096-0.115
Very Unhealthy	201-300	0.125-0.374	0.116-0.374
Hazardous	301-400	No Change	No Change
	401-500	No Change	No Change

- ◆ 6,100 cases of aggravated asthma,
- ◆ 243,000 people-days of missed work or school, and
- ◆ 750,000 people-days of restricted activities.

Based on the technology scenarios analyzed, the EPA estimates that

- ◆ the average estimated value of these and other health benefits would range from a low of \$2 billion to a high of \$17 billion per year in 2020, and that
- ◆ the average estimated costs of implementing a standard of 0.075 ppm would range from a low of \$7.6 billion to a high of \$8.8 billion in 2020.

## Expected Implementation Timeline for Revised Ozone NAAQS

Milestone	Date
Signature -- Final Rule	March 12, 2008
State Designation Recommendations to the EPA	No later than March 12, 2009 -- states and tribes have the option to recommend to the EPA which areas are and are not meeting the new standards.
Final Designations	No later than March 12, 2010 -- the EPA is required to issue final designations within 2 years after establishing revised standards
Attainment Demonstration SIPs Due	By 2013 -- the EPA will review existing designation guidance and communicate with states and tribes if additional guidance is needed.
Attainment Dates	2013-2030 (depends on severity of problem)

## Progress Toward Clean Air

While ozone's impacts on human health and the environment are more damaging than previously understood and occur at lower ozone concentrations, the EPA, states, and tribes have been making steady progress toward lowering the amount of ozone in the air. In recent years, ozone air quality trends have been improving. Ground level ozone declined 9% nationwide between 1990 and 2006, and in the eastern U.S., the cap-and-trade NO<sub>x</sub> Budget Program has proven very successful. There has been a 60% decline in eastern ozone season NO<sub>x</sub> emissions between 2000 and 2006, and a 13% decline in eastern O<sub>3</sub> concentrations between 2002 and 2006. Nationwide, 89 of the original 126 areas designated as nonattainment for the 1997 standard met that standard during the 2004-2006 period.



# Wichita Mountains National Wildlife Refuge, Oklahoma

The Wichita Mountains National Wildlife Refuge in southwestern Oklahoma hosts an IMPROVE sampler located near the headquarters, mounted on an elevated scaffold-type platform. The Oklahoma Dept. of Environmental Quality added a nephelometer to the site, and a mercury monitor nearby. The refuge has also operated a National Oceanic and Atmospheric Administration (NOAA) weather station for the past 102 years.



The terrain of the Wichita Mtns. is unlike anything most people would expect to find in Oklahoma. Granite rocky outcrops reach nearly 2,500 feet in elevation. Two wilderness areas lie in the refuge -- the Charons Garden Wilderness Area, whose eastern boundary is ¼ mile west of the IMPROVE site, and the North Mountain Wilderness Area five miles north.

The area has healthy herds of American bison, Rocky Mountain Elk, Texas long-horned cattle, and white-tailed deer. It was originally set aside as a forest preserve in 1901, and became a forest and game preserve in 1905. In the 1930s, the CCC and WPA constructed roads, fences, large concrete dams, and numerous buildings. The refuge receives about 1.5 million visitors per year to view wildlife, hike on numerous trails, and go 'boulder hopping'.



Ralph Bryant (top, right) and Tim Fischer (top, left) are the IMPROVE operators. Ralph is the deputy manager of the 59,020-acre refuge. He began his career with the Fish and Wildlife Service in 1974 and has been in the Wichita Mountains for 11 years. Tim, a mechanic with expertise in electrical and HVAC maintenance, has worked on the refuge for 10 years. Both get the opportunity to saddle-up the refuge's horses and assist with the annual bison and long-horned cattle round-ups, and the controlled elk and white-tailed deer hunts.



# November

“There must be a reason why some people can afford to live well. They must have worked for it. I only feel angry when I see waste -- when I see people throwing away things we could use.” - Mother Teresa (1910-1997), *A Gift for God*, 1975

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General Lab  
(530) 752-1123

**ARS: Optical:**  
Carter Blandford or  
Karen Rosener

**Photography:**  
Karen Fischer  
(970) 484-7941



# Measuring Light Elements by Rutherford Back Scattering

Lowell L. Ashbaugh, Omar F. Carvacho, Carlos M. Castaneda, Robert G. Flocchini, Jaspinder P. Singh, and Janice C.S. Lam; University of California, Crocker Nuclear Laboratory, Air Quality Group, Davis, CA

## Introduction

The Crocker Nuclear Laboratory (CNL) routinely performs X-ray fluorescence (XRF) analysis of aerosol samples to measure the concentration of elements with an atomic number greater than 10. In order to allow a more complete reconstruction of the aerosol mass, they recently began testing a Rutherford back scattering (RBS) technique to measure carbon (C) and oxygen (O) from air samples on Teflon filters using the 76-inch cyclotron at the lab.

The purpose of this procedure is to develop an additional method of measuring carbon, nitrogen, and oxygen on samples collected in the IMPROVE program. Carbon and nitrogen species are currently measured using conventional techniques.

## Method

For this test, the 4.5 MeV proton beam from the 76-inch CNL cyclotron located at the University of California, Davis was used.

A surface barrier detector (Si) for RBS was placed at 150 degrees to the beam axis and 170 mm from the center of an ORTEC 2800 series scattering chamber. Figure 1 shows the layout of the setup. The detector, 1000  $\mu\text{m}$  thick and 150  $\text{mm}^2$  in area, was collimated by a circular opening 4.8 mm in diameter (18.1  $\text{mm}^2$ ). The solid angle of the detector was measured to be  $6.25 \times 10^{-4}$  steradians (sr). The thickness of the detector stops the 4.5 MeV proton beam. Its measured resolution is better than 25 KeV. A similar detector to measure the hydrogen in the filter using forward proton elastic scattering was placed at 30 degrees to the beam axis. For completeness, an X-ray detector (AMPTK XR\_100CR) recorded characteristic X-rays from elements on the filter.

A Faraday cup (FC) with electric and magnetic electron suppression was located 105 cm from the center of the ORTEC chamber. To assure no protons were lost to the FC due to dispersion by the sample filters, a secondary electron emission monitor (SEEM) was placed before the samples. This SEEM was composed of three aluminized-Mylar foils of thickness 0.29  $\text{mg}/\text{cm}^2$  each. The monitor was calibrated to the FC with no filter present. Then, for all the runs the monitor was used to count the protons impinging on the samples. The size of the beam at the sample location was recorded using HD-810 Gafchromic film and was found to be 6.35 mm in diameter. The background was measured with beam on and no sample present, and no counts were observed from the detectors.

The spectra were collected with a multichannel analyzer using the Genie 2000 emulator software by Canberra Industries, Inc. Peaks in the spectra were integrated using the PeakFit software.



Figure 1: ORTEC 2800 series scattering chamber with RBS, proton elastic scattering analysis (PESA), and XRF detectors

Figure 2a: Spectrum of carbon standard foil with density of 300  $\mu\text{g}/\text{cm}^2$

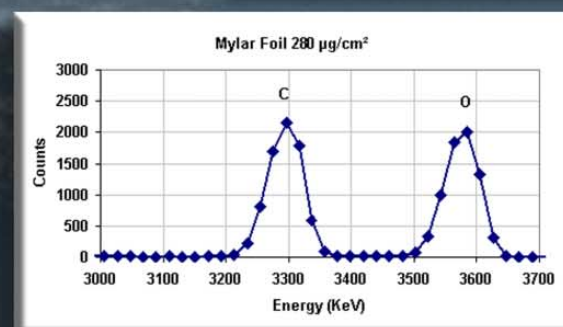
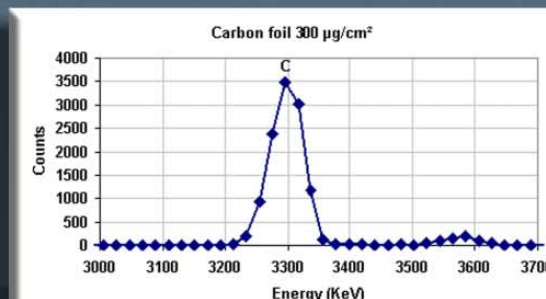


Figure 2b: Spectrum of Mylar foil with density of 280  $\mu\text{g}/\text{cm}^2$ .

Figure 3: A comparison between a blank Teflon filter and the same filter after loading with carbon (graphite).

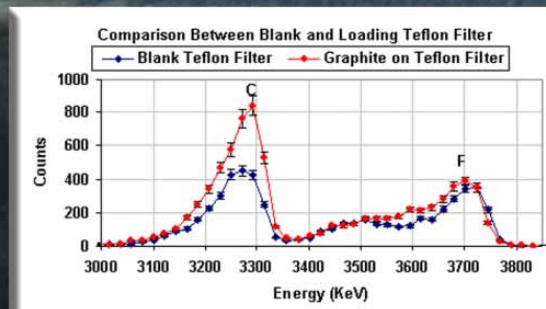
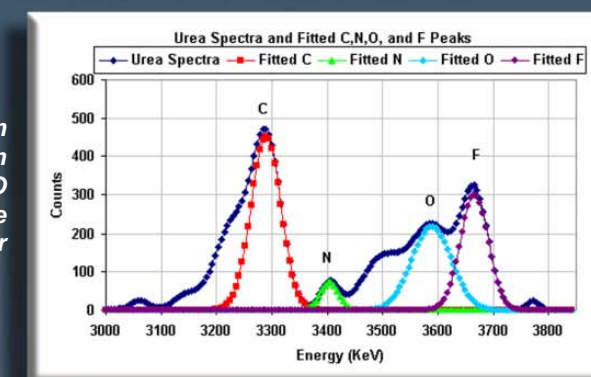


Figure 4: Urea spectrum comparison with fitted C, N, and O peaks using the PeakFit computer program



## Results

Two standards were used: a carbon foil with thickness of 300  $\mu\text{g}/\text{cm}^2$  and a Mylar foil with thickness of 280  $\mu\text{g}/\text{cm}^2$ . Figures 2a and 2b show the RBS spectra for both foils.

A blank Teflon filter was analyzed before and after loading with elemental carbon (graphite) using the CNL resuspension test chamber. The blank and loaded spectra are shown in Figure 3.

A blank Teflon filter was loaded with urea ( $\text{NH}_2\text{CONH}_2$ ) and analyzed using RBS for C, N, and O. The spectrum energies are shown in Table 1, and the spectra for C, N, and O on urea are shown in Figure 4.

Elements	Nuclear Reaction	Energy KeV	Elements	Nuclear Reaction	Energy KeV
Carbon	C(p,p)	3295	Fluorine	F(p, $\alpha$ )	3543
Nitrogen	N(p,p)	3445	Fluorine	F(p,p)	3697
Oxygen	O(p,p)	3563			

Table 1: Nuclear reaction and energies for C, N, O, and F

## Conclusions

An RBS analysis method has been developed and tested to measure the light elements carbon, nitrogen, and oxygen on Teflon filters. The method shows promise to extend the Crocker Nuclear Laboratory's analytical techniques to more completely determine the species that make up the measured mass on the filters.

Further development is needed and will be pursued in the coming months.



## Sula Ranger District, Bitterroot Natl. Forest, Montana



The Sula site sits atop Sula Peak at an elevation of 6,191 feet on the south end of the Bitterroot Valley. The Bitterroot National Forest encompasses 1.6 million acres and includes portions of the Selway-Bitterroot, Frank Church - River of No Return, and Anaconda-Pintler wilderness areas. This site offers great views of the wilderness areas off to the west and east of the site, and is a key visibility monitoring site as documented in the wilderness plans for the Selway-Bitterroot, Anaconda-Pintler, Rattlesnake, and Welcome Creek wilderness areas. It has been operated by fire personnel on the Sula Ranger District since 1994. The four operators, shown above from left to right, are *Jon Rupp*, *Tanya Neidhardt*, *Justin Abbey*, and *Melissa Wegner*. Secondary operators fill in throughout the season. These operators also monitor the National Trends Network site of the National Atmospheric Deposition Program when they're not out fighting wildland fires.



The weekly treks to the site lead to wonderful and often challenging situations in the winter months, due to blowing snow and cold conditions. These same conditions can also create challenges for the equipment in the colder months. Access to the site is by hiking, ATV, snowmobile, or snowshoes. Tanya Neidhardt reports it's always a great experience to make it to the top of the mountain and admire the views and see the many biological changes that occur from week-to-week throughout the year.



The Bitterroot Valley lies within Ravalli County, one of the fastest-growing areas in Montana. Collection of IMPROVE data from this site helps to determine trends on the national and local level, and is linked and assessed with other ongoing environmental monitoring within the region.

In general, visibility has been improving at the site, with wild- and prescribed-fire smoke a major variable. The trends are similar to other IMPROVE sites around USFS Region 1 in northern Idaho and western Montana.



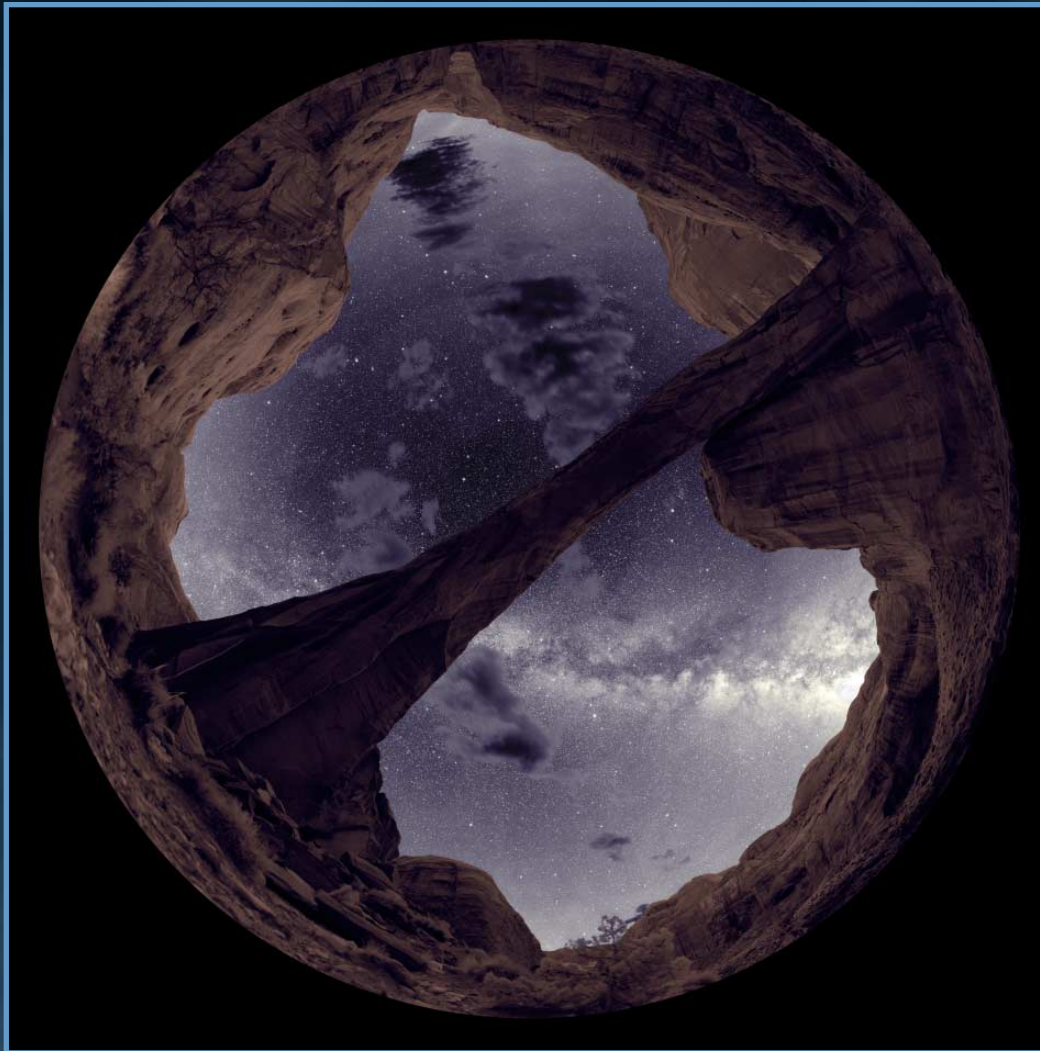
# December

"In the relations of man with the animals, with the flowers, with objects of creation, there is a great ethic, scarcely perceived as yet, which will at length break forth into light." - Victor Hugo (1802-1885)

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Operator Involvement -- The Key to Network Success





## Clear Dark Skies of Southern Utah

Original black & white image by Cindy and Dan Duriscoe.  
Copyright Cindy Duriscoe.

*The efforts made to monitor and protect air quality not only benefit daytime vistas, but the nighttime scenery as well. This image is a fisheye view of Rainbow Bridge of southern Utah. This site is managed by the National Park Service and sits between iconic Navajo Mountain and Lake Powell. Far from city lights and unencumbered by air pollution, the Milky Way is seen in stunning detail. The sandstone walls of the canyon are illuminated entirely by starlight in this long exposure. Though increasingly rare, such dark skies are an increasingly popular natural resource and sought by many city-weary travelers. The National Park Service has a team of scientists dedicated to protecting dark night skies and investigating the link between air quality and nighttime scenery.*

For questions or problems with optical or scene monitoring equipment, contact Mark Tigges, Air Resource Specialists, Ft. Collins, CO, at 970-224-9300.  
For questions or problems with air sampler controllers or filters, contact Jose Mojica or Steven Ixquiac, UC Davis, at 530-752-1123. For sampler audits, ask for Steven Ixquiac.

## IMPROVE STEERING COMMITTEE

IMPROVE Steering Committee members represent their respective agencies and meet periodically to establish and evaluate program goals and actions.  
IMPROVE-related questions within agencies should be directed to the agency's steering committee representative.

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Associate Membership in the  
IMPROVE Steering Committee  
is designed to foster additional  
comparable monitoring that will aid in  
understanding Class I area visibility,  
without upsetting the balance of  
organizational interests obtained by  
the steering committee participants.  
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